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TURACINE, A NEW ANIMAL PIGMENT CONTAINING COPPER.

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(*With a Coloured Plate.**)

Historical Notice.—All the colours which the feathers of birds display, are due either to what we may call the "optical" character of the surfaces of the web, or to the presence in it of definite colouring matters. These colouring matters have been as yet but very imperfectly studied. In two or three instances only have they been actually separated from the feathers containing them, while in no case have they been accurately examined from a chemical point of view. So far as I can learn, we have no exact information as to the amount and the chemical constitution, deportment, and reactions of those substances which M. Bogdanow, some ten years ago, succeeded in extracting from the red feathers of *Calurus auriceps* and *Catinga cærulea*. Without further retrospect, however, I will now give an outline of my own experiments in this direction, experiments which have led to some very interesting though unexpected results. First of all, then, as to the immediate origin of the present inquiry.

About two years ago, my friend Mr. W. B. Tegetmeier pointed out to me a singular property of the red feathers of the bird

* The plate represents *Turacus albocristatus* and *Musophaga violacea*, two of the birds from which the peculiar colouring matter has been obtained.

called the "plantain-eater." These feathers yield up their colouring matter to pure water, a beautiful rose-coloured solution being formed. Mr. Tegetmeier's attention had been drawn to this fact, and he at once saw that it was worthy of fuller investigation than it had already received. On further inquiry, I find that Mr. Ward, of Wigmore Street, had noticed the evanescence and solubility of the red tint in question many years ago, and that other observers within the last few years had even succeeded in staining pieces of paper with the coloured solution which these red feathers yield. When I commenced, in 1866, my experiments on this subject, I was not aware how far the investigation had been then carried, and how well ascertained was the interesting fact concerning the solubility of the red pigment in simple water. In order that it may be seen what was then the position of the inquiry, I will cite a few extracts from letters which have been placed at my disposal. These letters were written by Dr. Benjamin Hinde, principal Medical Officer on the Military Staff at Bathurst, on the Gambia, and I am indebted to the courtesy of Mr. Hugh Owen, of the Finance Department of the Great Western Railway, for the loan of them, and for other details concerning the present investigation. Here is a paragraph from one of Dr Hinde's letters, dated Bathurst, May, 1865. "I enclose a piece of paper stained with the crimson from the feather of the *Corythaix* (the *Musophaga violacea*, which is much more common here); all this colour came from the inch of feather enclosed. I also send some feathers partly washed: one of them especially, I have washed to a pale pink at the base, leaving the colour much darker at the tip. The moment soap touches them the colour runs, but I find it difficult to get it out in pure water. Nevertheless, the birds I sent home washed themselves nearly white in the water left for them to drink!" In a subsequent letter, Dr. Hinde gives some details concerning the different species of plantain-eaters, and also says with reference to the feathers he had previously sent to England—"all the feathers sent were from the same bird and grew in this house!" This fact negatives any idea of an artificial dye being present in the feathers, and is further referred to in the following memoranda, by Mr. Hugh Owen. "A pair of violet plantain-eaters from the Gold Coast were sent over to a friend in Ireland by Dr. Hinde. The birds arrived in excellent condition, and were speedily provided with ample space and all appliances for cleanliness. For a while the splendid plumage of the strangers, the brilliant crimson patch on the deep violet, nay, almost black, of the wing excited continual admiration. After a day or two the

crimson faded—in a few more the colour changed to a pale and dirty grey.

"The disappointed owner wrote an account of this change to Bathurst, concluding, of course, that the wily natives had imposed on Dr. H. by selling him a pair of painted birds; this was, however, impossible, there was no mistaking the peculiar and shield-shaped bill, or the legs of the Musophaga. Whatever change had taken place, the birds were genuine Touracos.

"Without delay another bird was procured, so young as to be only partly fledged, the wings only in the pin feathers. As soon as these were sufficiently grown, the experiment was tried, and the colours found to be inconstant and capable of extraction."

The data already given, and others with which I have been furnished, incontestibly prove the presence in the plantain-eater of a red pigment, soluble in water, and still more easily soluble in soap. I will now give my own results as to the isolation and chemical characters of this red animal pigment.

Sources of Turacine.—First of all, as to the bird, or I should say birds, from which I have succeeded in extracting this colouring matter. They are of several species, and generally go under the designation of plantain-eaters, the native African name for them being represented by the word Touraco; while the Dutch, I believe, speak of one of the species as the Cape Louri * (not Lory). These birds are entirely African. They belong to the Order Scansores, and the Family Cuculinæ. The Musophagides constitute the first section of this family, and to this section belong three genera, namely Turacus, Musophaga, and Shizorhis. From two species of Turacus, and one of Musophaga, I have procured the new red pigment. Here is a list, with localities, of these three species:—

Turacus albocristatus, Cape.
T. porphyreolophus, Natal.
Musophaga violacea, Gold Coast.

The plumage of these birds does not present any great general brilliancy. The dusky tints of most of the large feathers of the tail and the smaller feathers of the wings have usually a more or less decided green or violet metallic reflexion, while the wing coverts in some species are greenish, and of that variety of colouration which has been termed enamelled. The red pigment occurs in the primary and secondary pinion feathers, from twelve to fifteen of which have

* "Zoology," by J. Van der Hoeven; English edition of 1858; vol. ii., page 450.

either a crimson blotch upon them, or are almost wholly coloured. I propose the name Turacine for the crimson pigment which the Turacus contains. In order to extract this pigment the plan finally adopted was as follows :—

Preparation of Turacine.—The barbs constituting the red part of the web are stripped from the shaft of the feathers, placed in a beaker, and washed with ether and then with alcohol. This treatment removes the grease and adherent dirt very effectually. When the red barbs thus washed have been dried between folds of filter paper they are placed in a cold, very dilute, solution of caustic soda—a solution containing one part of alkali in five thousand of distilled water being quite strong enough. Ammonia, potash, or the carbonated alkalis may be used in lieu of caustic soda. The mass is stirred at intervals for fifteen minutes or thereabouts: the red solution is poured off and pure water added: by successive treatments with fresh portions of dilute alkali and pure water, the whole of the crimson pigment is obtained in solution, and the residual barbs are left white or pinky grey. All the coloured liquors having been mixed, they are poured in a slender stream with constant stirring into dilute hydrochloric acid made by mixing one part of the commercial acid with nine parts of water. When the red precipitate of the pigment thus rendered insoluble has settled, the supernatant liquid is decanted off and the red matter thrown upon a wetted filter and washed with water. The liquid comes through quite colourless until there is no longer any trace of acid left in the pigment on the filter. When this occurs the residue on the filter is washed with water containing a few drops of acetic acid to the pint of water, and then syringed out of the filter into an evaporating basin, and dried at a gentle heat. The dry pigment is next to be washed with a mixture of alcohol and ether and once more dried. It is now perfectly pure and yet unchanged, so far as I have examined it.

Properties of Turacine.—The following are the chief characteristics of the new pigment, turacine. Prepared as before described, it occurs in scales having a deep violet purple colour by reflected light, and showing a crimson tint when seen in small fragments by transmitted light. It has not yet been obtained in a crystalline form. It is slightly soluble in pure water, giving a rose-red liquid. The presence of acids and salts renders water incapable of dissolving it. It is not soluble in pure alcohol or ether. In alkaline liquids of all kinds it immediately dissolves, forming solutions which show a bluer tint than that of the original pigment. Very strong solutions of the caustic alkalies dissolve the pigment, but at the same

time it suffers a partial decomposition, evidenced by an odour, resembling that of certain organic bases which it then evolves. Fuming nitric acid dissolves it with a deep brown tint, destroying it; in oil of vitriol it is soluble with partial alteration. Turacine seems to have slightly acid properties.

Turacine by long exposure to air and moisture, or by long continued ebullition with water acquires a colour closely resembling that of chlorophyll.

Spectrum of Turacine.—A few of the red barbs of *Turacus albocristatus* were placed under the micro-spectroscope, and two black bands were at once perceived in the space between the lines D and *b* of the solar spectrum. These bands correspond very closely in position and breadth with those of Stokes's red cruorine, but I am not prepared to affirm that they are identical. When an alkaline solution of turacine is similarly examined, the bands seem shifted further from D, while the blue region of the spectrum is less shaded than it is with the original red barbs, or with coagulated turacine precipitated from its alkaline solution by an acid. When the alkaline solution of turacine is weak, the band near *b* is very weak, but when a strong solution is employed, both bands become equally dark, and finally almost coalesce, nearly obliterating the space in the green between them. No definite results have attended my attempt to produce in turacine, by ferrous or stannous salts, a similar reduction to that obtained in the case of red cruorine by the same means. I fancied, however, that the band near *b* became less distinct after this treatment of turacine. Coagulated turacine in water, and the web of the red feathers, present exactly the appearance of diluted arterial blood to the eye.

Composition of Turacine.—Turacine may be heated to 100° C. without change, but at a much higher temperature its surface-colour alters, becoming bluish, and then a dull green. Afterwards it shows some signs of fusion, giving off a violet vapour closely resembling than of iodine, and finally burns away, leaving a greyish black ash. The volatile constituents of turacine are carbon, hydrogen, nitrogen, and oxygen, in what proportions I have not yet ascertained, but I have submitted the ash or non-volatile constituents of the new pigment to a careful examination.

The close resemblance of turacine to cruorine induced me to test at once, in the ash of the new pigment, for iron, the characteristic metallic constituent of the colouring matter of the blood. The ash was dissolved in nitric acid, excess of sodic acetate added, and then potassic ferrocyanide. To my astonishment, instead of the deep blue

of the ferric ferrocyanide, the rich purple brown precipitate of the cupric ferrocyanide was at once seen. Not only was copper present, but there was so much of it that it could be detected by its spectrum in a few of the red barbs of the original feathers, by burning them on a platinum wire, moistening them with strong hydrochloric acid, and then placing the ash in the flame of a Bunsen burner.

This detection of copper in the colouring matter was so extraordinary, that I determined to sift the matter thoroughly. My first thought was that a preservative solution containing cupric sulphate had been employed in dressing the skin of the birds; but I soon found this notion untenable, for there is no copper in any part of the bird save in the red feathers, and in these feathers themselves the presence of copper is strictly confined to the red barbs. Even barbs that are partly red and partly black contain no copper in their black parts, and abundance in those which are red. Moreover, as acids do not wash out the copper from the feathers, and the most severe chemical treatment short of actual destruction of the pigment itself does not remove it from the prepared and pure turacine, it is evident that this metal, copper, is an integral constituent of the substance under investigation. To give an idea of the intimate union between the copper and the other constituent elements of the colouring matter, I may mention that I once dissolved some turacine in oil of vitriol, diluted with half its bulk of water, precipitated the turacine again by sodic acetate, and found that there had been no loss of copper by solution in the strong acid.

I have examined with care the different parts of eighty-seven red feathers of *Turacus albocristatus*. From the red barbs of these some of the colour which I examined was prepared, but their shafts were submitted to dissection. The clear horny parts, or quills proper, at the base of each feather, were cut off, and separately incinerated: so also were the upper parts or shafts of the eighty-seven feathers, and in like manner the membranes found in the quills. There was no copper in the ash of the eighty-seven quills, and none in that of the membranes; but a very minute trace was found in that of the shafts.

There is, therefore, no possibility of any mistake having occurred as to the copper present in the red parts of the feathers of the Touracos. It cannot have been introduced in any preservative solution, for it would then be found in the black parts of the web as well as in the red; it cannot be an artificial dye, for birds bred in

captivity acquire the cupreous pigment naturally; it cannot be an accidental and unnecessary constituent of the red colouring matter, for not only is it impossible to remove it from the colour, but the proportion of copper present in the turacine obtained from different individual birds remain constant. I will now state what this proportion is.

In my first analysis I employed acetic acid to precipitate the turacine from the alkaline extract of the feathers. Now, on burning some turacine thus prepared, I found that it left a very considerable amount of ash, nearly twice as much as in subsequent experiments where hydrochloric acid had been used as the precipitant of the pigment. Some calcic and magnesic phosphates had obstinately adhered to the precipitated turacine, and were found in the ash. The same salts accompany the colouring matter of blood with similar tenacity. But it was soon found that the new pigment might be obtained in such a state of purity as to leave no other ash when burnt than nearly pure cupric oxide, oxide of copper! the seven per cent. of calcic phosphate, and the traces of other substances having been previously removed by the action of dilute hydrochloric acid, without any change in the turacine itself. The results of very careful determinations of the amount of copper in two different specimens of pure turacine were quite accordant, one analysis (the details of which it is not necessary to give here) affording me 7·20 parts of black oxide of copper in 100 parts of turacine; the other yielding 7·38 parts. These proportions correspond respectively to 5·75 and 5·89 parts of metallic copper in 100 of the red pigment. I am inclined to think that this amount is really rather below the true per centage, but this point is now being further investigated.

Affinities of Turacine.—Although in its colour, in its absorption spectrum, and in some of its other characters, turacine corresponds very closely with the scarlet cruorine of blood, yet it contains no iron, or the merest trace of that metal. Iron, however, exists to the extent of between six and seven per cent. in hæmatine, the chief derived colouring matter obtained from blood, and is doubtless an essential constituent of the original scarlet cruorine; but I venture to hazard the conjecture, that in turacine copper replaces the iron of cruorine, and that this new pigment is, after all, a *copper cruorine*. Still it does not occur in corpuscles, but homogeneously distributed in the barbs, barbules, and crochets of the red feathers of the birds in which I have found it. It would seem to characterize the closely-allied genera Musophaga and Turacus. It is most abundant at the pairing season, and the bridal plumage of a

Turacus albocristatus generally yields about three grains of the pigment.

Turacine is the first animal or vegetable pigment, containing copper as an essential element, which has been hitherto isolated; yet traces of copper have been repeatedly found both in animals and plants. It was detected by Harless in the blood of certain Ascidia and Cephalopoda. It occurs in *Limulus cyclops*, *Cancer pagurus*, *Acanthias zeus*, and *Conger vulgaris*, its amount being in an inverse ratio to the quantity of iron present. The blood of *Helix pomatia* also contains much copper, the part of the ash insoluble in water yielding 2·57 per cent. Many chemists have detected minute traces of copper even in human blood, and twenty years ago Deschamps arrived at the conclusion that it is normally contained in the blood of man and animals, being in the first place taken up by plants from the soil. Odling and Dupré have indeed subsequently detected copper in flour, straw, hay, meat, eggs, cheese, and other articles of food. It is not, therefore, difficult to perceive whence the Touracos, or plaintain-eaters, derive the copper which their red feathers contain. The vegetable food on which they subsist doubtless contains this metal, and I have indeed succeeded in obtaining indications of copper from the ash of three fruits of a plantain, the common *Musa sapientum*, purchased of a London fruiterer. There is, of course, still room for experiment and further observation in this direction. Researches as to the sources of copper whence vegetables assimilate it, the occurrence of ores of copper near the habitats of the Touracos, and its detection in the articles of food supplied to these birds when kept in captivity, will doubtless lead to interesting results. I am now pursuing these inquiries, and at the same time completing the investigation of those properties of turacine which have been outlined in the present paper.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER II.

THE WOMEN OF TEUTONIC MYTHOLOGY AND ROMANCE.

At the close of our preceding chapter, we left Western Europe on the eve of a mighty revolution. We must not suppose that its dominant population belonged any longer to the old Celtic races, but, on the contrary, it was a mixture—we may fairly say an amalgamation of different races from many parts of the Roman empire. In the few instances I have already given, we have Vangiones from Belgium, in one of the towns in the north of Britain, and people from Salona in another, and we have seen people of Greek origin at Lyons, on the Rhone. It was the policy of the Romans to colonize permanently the territories they had conquered in more distant and less civilized parts, and the first towns in these parts were Roman military colonies, and the inhabitants soldiers, with their relatives, and people who accompanied them. In most places, each town, or station, appears to have been occupied by an uniform population from the same country, and to have been generally recruited from that same country; but in course of time the circumstances altered, and the soldiers, or, in other words, the townsmen, were recruited from any part of the Roman empire most convenient. The population became thus very mixed in its ethnological character; but this was probably not outwardly observable from the circumstance that it had all become outwardly Roman. This was, no doubt, still more the case in Britain than in Gaul, in some parts of which the original Celtic population had possessed towns before the Roman conquests. The great source from which the population was thus recruited in Northern Gaul and Britain during the later Roman period appears to have been Germany, and many facts lead us to believe there was in these countries a very considerable population of Teutonic blood long before the time when the authority of Rome was withdrawn. Our second chapter

thus introduces us to that great Teutonic race, from which we ourselves claim to be descended.

Fortunately, too, with our German forefathers, the materials of history begin to be clearer and more copious, and we shall soon be able to treat our subject much more satisfactorily. But before we consider the primitive Teutons as they lived upon this earth, we will pay a visit to them in their heaven above, for it should be in their mythology and mythic romance that we shall be able to learn the Teutonic *idea* of Womankind. The outline of the primitive mythology of our Teutonic race has been preserved to us in the two Eddas, the first of which consists of a series of the early Scandinavian mythic poems collected in the latter part of the eleventh century by a priest named Sæmund; the other, which is known as the Prose Edda, formed, about half a century later, chiefly from the songs of the elder Edda, by another priest named Snorro.*

According to this Scandinavian mythology, there were three principal worlds, or, as they called them, gards, *i.e.*, yards, or inclosed residences. Towards the south was Asagard, the residence of the Asas, or gods; to the north was Utgard, or the outer residence, otherwise called Jotunheim, or the home of the Jotuns (in Anglo-Saxon eotens), or giants; and between them lay Midgard, or the middle residence, which was the earth, inhabited by men. The giants, or evil beings, had existed before the gods, and therefore, through longer experience, possessed greater knowledge of things. The oldest and highest of the gods was Odin, as he was called by the Scandinavians, or Woden, as the name was pronounced in the German dialects, including our Anglo-Saxon. Odin had many names and epithets, but he was most commonly spoken of as Allfadur, or the Father of All things. His wife was the goddess Frigga, who was spoken of as the Mother of All; and from them were descended the other gods and godesses. Odin was in possession of the precious liquor, the drinking of which produced poetry, and which he had stolen from the dwarfs in a rather dishonest manner. It was the etiquette among the gods to talk in verse, and the language of poetry, whether we find it in the primæval dialects of Scandinavia, or in Anglo-Saxon, is full of metaphor and imagery, which, though often extravagant, is sometimes remarkable for its beauty. Several of these metaphorical phrases have relation to Womankind. Thus Odin himself is called Friggiar faþmbygguir, *i.e.*, the inhabitant of the bosom of Frigga, meaning her husband;

* The edition I use of the Poetic Edda, or Sæmund's Edda, is that of Copenhagen, in 3 vols., 4to.

and similiarly Loki, the least worthy of the gods, is spoken of in another of the Edda songs, as Farmr Signyiar arma, the burthen of the arms of Signyia, his wife. Still more elegant was the metaphor usually employed in Anglo-Saxon poetry for a woman—freóðu-webbe, a weaver of peace. In Beowulf, it is said of the hero's aunt Hygd, the wife of Hygelac, whom she was accused of having murdered—

ne bið swylc cwénlíc þeáw,	such is no womanly custom,
* * *	* * *
þætte freóðu-webbe	that a peace-weaver
feores onsæce,	plot against the life,
æfter lig-torne,	after burning anger,
leófne mannan.	of a dear man.

"Beowulf," l. 3884.

And at the opening of the fragment called the Gleeman's Tale, we are told that Widsith travelled in company with his wife to visit the Hreth-king's court—

he mid Ealhhilde,	he with Ealhhild,
fælre freóðu-webban,	faithful peace-weaver,

that is, faithful woman. The beauty of the metaphor will be still better appreciated if we bear in mind that the chief domestic occupation of Womankind among the different branches of the Teutonic race, was weaving. It is an assertion of one of the most precious attributes of the sex. The principal building in Asagard was Walhalla, the Hall of Slaughter, in which the souls of men who fell bravely in battle, lived and feasted. Odin had a high seat or throne, from which, when seated upon it, he overlooked the universe, and on which none of the Asas was permitted to sit, except Odin and Frigga.

Once, in the morning of time, to use still the metaphorical language of this old poetry, the Allfather was sitting upon his seat, and the Mother of All sat by his side. The god, like a good husband, said to his spouse, "Give me thy counsel now, Frigga, for I have an earnest desire to visit Vafthrudnis, and to dispute with that all-knowing giant on points of ancient knowledge." Frigga, who knew that it was a long journey beset with dangers, and that Vafthrudnis was the strongest, as well as the most learned, of the giants, would have persuaded Odin to remain at home; but she found him resolutely bent upon the adventure,—like some husbands of more earthly character, he had evidently made up his mind what to do before he asked his wife's advice upon it; and, seeing this,

the goddess gave him affectionately her parting wishes for his safety. For those who may wish to know what was the language spoken by the Mother of All, I repeat her words as they are given in the opening of the Edda. Frigga said to Odin—

heill þu farir !	safe be thou in going !
heill þu aptr komer !	safe be thou in coming back !
heill þu Asynnom ser !	safe be thou for the goddesses !
öþi þer dugi	may thy talent be sufficient
hvars þu scalt, or alldafauþr,	wherever thou shalt have need, our Allfather,
orþom mæla Jotun.	to address the giant with words.

Odin seems to have had two objects in view—first, to obtain knowledge from the all-knowing giant, which he proposed to do by going in the diguise of a poor traveller, and drawing out from him information which he would not otherwise give; and, secondly, to spy the country, or, as he expresses it, to see what sort of halls Vafthrudnis lived in. Accordingly, Allfather presents himself in disguise under the name of Gangrad, the traveller, and the rest of the poem is a continuous conversation between the Asa and the giant, so arranged as to give an elementary outline of the primitive mythology. Here and there, among these obscure songs of a remote age, we gain a hint of the position of Womankind among the gods. In the För Skirnis, or Journey of Skirner, who went to gain the love of Gerda for Thor's son, Njörd, the daughter of a Jotun, the damsel acts quite independently of her father. In the Harbarz Lioth, or Song of Harbard, the ferryman, in which Thor, Odin's eldest son, and the first of the gods under him, and Harbard tell each other their adventures, to the question, "What wert thou doing, Thor?" the god replies, "I was beating the wives of the giants in Hlesey, for the wickedness they had perpetrated towards mankind." Harbard then remarks, "It was a disgraceful act that thou committedst, Thor, when thou gavest blows to women." Thor felt the reproach, and excused himself by urging that these were wolves rather than women. Facts like these show us woman, according to the primitive ideas of our race, in a position of dignity far different from that of savages.

In the songs of the Edda, the goddesses are not only represented as sitting in the hall on an equality with the gods, but they also meet in council together on the same footing, and give their opinions, which are listened to with respect. At the opening of the Vegtams-Quitha, we find the Asas of both sexes thus assembled in council to debate on the danger with which the young Baldur

had been threatened in a dream. In Thrym's Quida, likewise, the gods and goddesses sit and act together in the council held to consult on the proposal to disguise Thor in the dress of a bride. In the Ægis-Drecka, or Æger's banquet, the social position of the goddesses is quite equal to that of their husbands, they take the same share in the conversation, and come in for the same share of the insults of the base Loki, the most wicked of the gods. According to this story, Æger gave a great feast to the Asas, to which came Odin and his wife Frigga. Thor came not, as he was absent in another part of the universe, but his wife, Sifia, attended alone. Among others present at this entertainment were Bragi, and his wife Idunna; Njörd, and his wife Skadi, and Freyja, the goddess of Love. Loki, who was one of the party, showed his natural perversity by slaying one of Æger's attendants, in consequence of which he was expelled from the hall, and forbidden to return. Nevertheless, he soon presents himself again, and demands his horn of mead. He is received in silence, with the exception of a gentle rebuke from Bragi; but a seat is granted him, and he takes his place, and drinks to the assembled Asas, excepting Bragi, whom he accuses of cowardice. Bragi replies, and his wife interferes to prevent an unseemly brawl; but Loki insults Idunna, and charges her with disgraceful licentiousness. The goddess Gefion, who was celebrated for her chastity, is subjected to a similar charge, nor are Frigga herself, or Freyja, the goddess of love, or Skadi, or any of the other goddesses, spared from the same or even worse imputations, until Thor makes his appearance, and drives away the turbulent intruder. If we judge by the imputations thus freely scattered among the goddesses by Loki, we might be led to form a rather low estimate of their characters; but the old writers intimate that the greater part, at least, of his charges were no better than a mere ungrounded libel. Yet we learn from other parts of the Eddas that neither goddesses nor gods were totally unacquainted with intrigues, and in this respect, indeed, they seem to have resembled, to some degree, the deities of classic fable. Most of the gods of the Teutonic mythology had several wives—the number of Odin's wives was rather considerable—so that polygamy was certainly countenanced in Asagard.

A list of the goddesses of our primitive mythology, with their character, is given in the prose "Edda," or "Snorro's Edda." Eir was the goddess of medicine. Gefion was the maiden goddess, and all females who died maids became her handmaidens. The fifth in

the Edda list was Fulla, who was likewise a maid, and who went with her hair flowing over her shoulders, and her head adorned with a gold ribbon. She was entrusted with the toilette and slippers of Frigga, and was the confidential repository of her secrets. The next of the goddesses in rank after Frigga, the Mother of All, was Freyja, who possessed the celebrated necklace Brising, answering to the cestus of Venus, who holds in classical mythology nearly the same position as Freyja in that of the North. The goddesses of Asagard are almost all gentle and affectionate in temper. The husband of Freyja is described as leaving his wife in order to travel into very remote countries; the goddess, after wandering through many countries in vain search for him, returned home, and passes her time in continually weeping for his absence. She weeps tears of gold. The "Edda" song, "Fiöl-Svinns Mal," concludes with a passage describing, in simple but touching terms, the joy of two lovers of the Asa race on their re-union after a long separation. Several of the goddesses presided over the affections of men and women, and over affairs of love. There were different classes of goddesses of inferior rank, such as the Valkyrier, who were present at battles, and selected those who were to be slain, and the Norni, or fates. Even these seem to be gentle and affectionate, when not engaged in their sanguinary duties, which, too, were looked upon as beneficent acts, as it was considered the greatest of God's bounties to take a man direct to Walhalla. The Valkyrier waited upon the heroes in the hall of Walhalla. It was, indeed, one of the great duties of the high Teutonic dame, to serve the mead or other drink to her husband's guests in the hall.

Our information on the costume of the fair goddesses of Asagard is unfortunately very scant. They were evidently proud of adorning their persons with a profusion of jewellery. Freyja had rings of gold on her hands, and a necklace of gold round the neck. The latter seems to have been a usual ornament; one of the heroines of the "Edda," Menglad, took her name from the brilliance of her necklace. The goddesses appear to have been especially proud of the whiteness of their arms, which they washed diligently. In the "Ægis-Drecka," Loki compliments Idunna on her arms being "excellently washed" (arma þína ítr-þvegna). From this we may assume that the dress had no sleeves, but that the arms were left bare. The material appears to have been usually linen, which they wove at home. In the "Thryms-Quida," Freyja is recommended to put on her "bridal linen" (brudar líni). In this particular case, we have, at all events, some account of the manner in which a

goddess dressed for her marriage. Thor had lost his famous hammer, which was in the power of Thrym, one of the Jotuns, or giants. Thrym refuses to give it up on any other condition than that Freyja shall be given to him for a wife. Loki persuades Thor to go with him to the court of the Jotun disguised in the garb of Freyja, and act the part of the bride. Accordingly they bound round Thor the bridal linen, placed round his neck "the great glittering necklace," made the keys ring under it, and the female vest (kvenvâþir) to flow about the knees. The keys were hung to the girdle as symbolical of the duties and cares of the new bride. They placed broad gems on his breast, and a band round the top of his head. It appears to have been the custom to cover the bride with a thick veil on these occasions, and Thor's disguise proved safe except in as far as he nearly betrayed himself by his own indiscretion; for the god, who was renowned for his appetite, was no sooner seated at the table in Thrym's hall, than he eat without halting an entire ox, eight salmons, and all the dainties which are usually served to ladies under such circumstances, and with it he drank three hogsheads of mead. Thrym, giant as he was, felt somewhat surprised at the appetite of his betrothed, and said, "I never saw a bride eat more at a meal, or a maiden drink a larger quantity of mead." Loki excused her by stating that so anxious had she been for the time when she was to go to Jotenheim, that she had eaten nothing for eight days and eight nights. Thrym next sought to obtain a glance at the face of his bride by lifting up the corner of her linen, but he drew back in terror, with a remark on the fierceness of her eyes. This is explained by the assertion that she had not slept during eight days and eight nights. At length the hammer is produced, and the moment Thor feels it in his hand he assumes his true character, and destroys Thrym and all his household.

From Asagard and Walhalla, we come down to Odin's more distant descendants, who have not yet passed under the judgment of the Valkyries; and whose sphere of action lies within the limits of Midgard, or this earth. Their legends, some of which occupy a part of the Edda songs, bring us out of the region of pure mythology into that of romance, and to the very bounds of history itself. In them, Womankind oft takes a more boldly-defined position than in the mythology. The great qualities of woman often influence, either for good or for evil, the whole course of events more powerfully than those of man. In fact, in these mythic romances, woman begins to appear as the great moving

force of the history. There is one great cycle which runs through a number of the later songs of the Edda, and which may be taken as an example of the earlier class of these romances. It will be remarked how it rises out of the merely mythic and poetical into something like the real. The great family of the Volsungs, descended immediately from Odin, was represented at the time when this story begins by a prince named Sigurd, who had obtained the power of understanding the language of birds. One day he heard the birds talking of a beautiful maiden whose name was Brunhild, and who waited for a liberator of the other sex. She was a Valkyrie, who had offended Odin, and in return had been condemned to abandon her condition of Valkyrie, to submit to marriage, and to be subject to death. She had been thrown, clad as she was in her armour, into a magic sleep, and placed on the top of a mountain surrounded by a barrier of flames; the hero who should pass the fiery barrier and rescue her, was destined to be her husband. Sigurd resolves to undertake the adventure, and succeeds, but he leaves Brunhild with a promise upon oath to return and take her away as his wife. Sigurd then proceeds to the country of the Niflungs, and forms a friendship with their three kings, the brothers Gunar, Hogni, and Guttorm. Their sister Gudruna becomes enamoured of him, and, through a magic potion administered to him by her mother, he forgets his vows to Brunhild, and marries Gudruna. Sometime afterwards, Gunar, the eldest of the three brothers, hears the story of Brunhild, and determines to obtain possession of her. He secures the assistance of Sigurd, who alone has the power of passing through the flames, and by this means Brunhild is brought away and married to Gunar. But the Valkyrie retains her passion for Sigurd, and had forgotten nothing that had passed, and she now only seeks to punish him for his desertion. She excites her husband Gunar and her brothers against him, and in the sequel Sigurd is slain by them. Brunhild immediately repents of her deed, laments the fate of Sigurd, slays herself, and is burnt on the same funeral pile, leaving her curse upon Gunar and his brothers. The Edda songs go on to tell the vengeance which fell severally upon the three princes of the Niflungs. Subsequently their sister Gudruna makes her appearance again as the wife of Attila, whom she slays at a feast; and the story continues through a new series of feuds and slaughters.

These Edda songs, which present the earliest form of what was afterwards expanded into the grand German mediæval romance of the Nibelungen-Lied, or song of the Nibelungs, picture Woman-

kind not in her most pleasing colours. We have in our Anglo-Saxon literature only one representative of these mythic romances, the poem of Beowulf; but we cannot but feel that in this venerable relic left to us by our forefathers, the other sex appears to us more domestic in character, and in more amiable colours, than in the story of Brunhild. The name of Beowulf figures as one of the early links in the Anglo-Saxon mythic genealogy of the race of the Anglo-Saxon kings.

Hrothgar was a king in Denmark, who had built for himself a princely residence, to which he gave the name of Heorot; but it was visited by a fiendish being named Grendel, who carried off Hrothgar's nobles to devour them in his retreat, and none had the power to resist. Beowulf reigned over the Geats, or Goths of West Gothland, and, hearing by fame of the distress of Hrothgar's court, he proceeded thither with a party of his warriors, in the true character of the mythic hero, in order to combat the monsters. Beowulf is joyfully received in Hrothgar's hall, and the scene of feasting, the story-telling, the minstrel's song, the boisterous mirth, are all graphically described. Then, in due time, Hrothgar's queen, the noble Wealhtheow, the "gold-adorned" (gold-hroden), advanced from her seat, to bear the cup to the warriors. First she offered it to the king her husband, greetingly "bade him be blithe at the beer-drinking, he who was dear to his people." Then she went round the hall, offering the cup, and distributing gifts to each. At length "the ring-adorned queen, exalted in mind," bore the mead-cup to Beowulf himself, and "sagacious in words" (wisfæst wordum), addressed the hero in flattering terms. Beowulf replied that he intended to destroy the Grendel or die in the attempt. There and then :—

eóde gold-hroden	went gold-adorned
freólicu folc-cwén	the joyful people's-queen
to hire freán sittan	to sit by her lord.

"Beowulf," l. 1285.

The "joy in hall" was then renewed, until Wealhtheow retired to her bed, and Hrothgar soon followed. I will not enter into the details of the combat in which Beowulf gave the Grendel its mortal wound: other feasts in the hall followed, in which the queen, to whom the poet applies the epithet of "peaceful tie of peoples" (friðu-sibb folca), rewarded the hero with princely gifts, while Hrothgar's daughter carried round the cup.

We see that there is not much scope in "Beowulf" for bringing

forward the character of the female sex; and unfortunately we have no other Anglo-Saxon romance of the same class left in anything like its original state. There is one other early romance, however, which is worthy of attention. It is that of Walthere, Latinized into Waltharius, and preserved only in a Latin metrical version, supposed to have been made in the tenth century.*

It was the age when Attila with his Huns was ravaging the centre of Europe, and he was already directing his march against the kingdom of the Franks, when Gibico, who was then their king, took counsel of his nobles, and resolved to save his people from the horrors of invasion, by making his peace with Attila, and paying him a tribute. The offer was accepted, and a young Frankish noble, named Hagano, was delivered as a hostage, accompanied with a large mass of treasure. Attila now turned his arms against Burgundy, where Herric was king, who had an only daughter named Hildegund, remarkable for her beauty. Herric followed the example of the king of the Franks, made his peace with Attila, and his daughter Hildegund became his hostage. The Aquitanians submitted to the same conditions, and their king, Alphere, gave as hostage his son Walthere, a young prince of great promise. Now Herric and Alphere had already entered into a treaty for the marriage of Walthere and Hildegund, so that the couple, ignorant of the engagement made by their fathers, went into exile together. It is an example of the authority of a father over his children. So Attila returned with his hostages into Pannonia, where they were treated at his court with great kindness, as though they had been his own children, and the maiden was given in charge to the queen. The two young princes were trained to arms, and became distinguished among the warriors of Attila's army; while the maiden rose rapidly in the favour of his queen, whom she pleased by her noble manners, and by her industry in her domestic duties, until she was at length made keeper of the royal treasures, and her influence was almost equal to that of the queen herself.

> "Moribus eximiis operumque industria abundans;
> Postremum custos thesauris provida cunctis
> Efficitur, modicumque deest quin regnet et ipsa."
>
> "Waltharius," l. 112.

We have seen in "Beowulf" that it was the lady of the household who distributed the gifts of her husband's treasures to his guests

* The "Waltharius" has been printed several times. The edition I use is that by M. Edélestand du Méril, given in his "Poésies Populaires Latines," Paris, 1843.

in the hall, and she appears also to have had them in her keeping. During this time the king of the Franks died, and was succeeded by Gunthere, who immediately threw up his dependence upon Attila, and refused his tribute; and the Frankish hostage, Hagano, made his escape from Attila's court, and fled back to his home. But Walthere remained one of the most distinguished leaders in the army of the Huns, and their king, at the suggestion of his wife, sought to retain him by pressing upon him a Hunnish wife. But Walthere found, or pretended to find, an excuse for declining this proposal in the plea that the attractions of a female companion might withdraw him from, or make him less eager in, his path of glory. At length, on his return from a great victory he had gained for the Huns, Walthere, in a private interview with Hildegund, becomes enamoured of her while she is offering him the festive cup, still ignorant of the treaty of alliance which their fathers had formed for them. The result is, they agree to fly together, and make their way to the land of the Burgundians. As the opportunity for their escape, they choose a great feast-day, at which Walthere contrives that the whole royal household shall be made more drunk than usual, and, when they are all stretched helpless on the floor, he selects a swift horse from the stables, arms himself, and carries with him part of the king's most valuable treasures, and with his lover makes for the forest. Their adventures on the way, their dangers and escapes, the patience and constancy of the lady, and their final success, form the subject of the remainder of the poem. The romance of Walthere may be considered as belonging to that branch of the Teutonic race which established itself in Gaul.

VARIATIONS OF ANIMALS AND PLANTS UNDER DOMESTICATION.*

Charles Lyell and Charles Darwin are the two men who have most deeply affected the tone of scientific thought of the present generation. The one, assisted by a host of followers, has abolished spasmodic geology, and the other has contributed more than any other writer to suggest views of development in affinity with that exceedingly slow and orderly progression of the physical frame of the earth from one stage to another, which palæontological and

* "The Varieties of Animals and Plants under Domestication." By Charles Darwin, M.A., F.R.S., etc. 2 vols., with illustrations. John Murray.

lithological investigations have established beyond a doubt. The Darwinian theory may or may not account for the whole range of facts involved in the "Origin of Species," but the principles expounded by Mr. Darwin cannot be denied to exert, at the present time, a very important action upon organic beings, and to have exerted a similar action in past periods to an extent which must have been enormous though its limitations are unknown. Formerly, with the exception of a few daring minds, speculative science tried to accommodate itself to the prevailing theory that our globe was a novelty of some six thousand years date. Geology has completely overthrown this notion, and it is remarkable that while students of this particular science have made increasing demands upon time, they have been followed by investigators in almost all departments of knowledge. The ethnologist, the philologist, the anthropologist, the cultivator of the new and rising science of comparative mythology, all require the lapse of ages to account for the phenomena which their researches disclose, and the astronomer, reinforced by recent discovery in the belief in what is called the "nebular hypothesis," regards our planet as a portion of a system to which a great, though at present an incalculable antiquity must be assigned. Objections to Darwinism founded upon the time required for the supposed methods of operation now only linger in those portions of society which, considered from a scientific point of view, must be regarded as the least informed; but difficulties of other descriptions remain scarcely touched by accumulation of facts or by ingenuity of hypothesis. The opponent of Darwinism who repeats the old demand for connecting links, is indeed satisfactorily answered to a certain extent. Originally his question was based upon the belief that if numerous so-called species had descended from a common ancestor, or pair of ancestors, the transition forms ought to be abundantly discovered in living beings, or in the geologic record. If, instead of having to account for all the known changes in organic life, and in the structure of the earth-crust, by the supposition of causes acting very slowly and gradually, philosophers had only been allowed to add a few thousand years to the accepted chronology, they must have supposed natural operations so crowded together that the earliest parents and their remotest descendants could have been but slightly separated from each other, and immense portions of the whole scheme might have been simultaneously viewed at a single glance. But this is known not to be the case. Little progress has been made in converting geologic time into historic time, but the scheme of organic life as

unfolded by modern discovery, is so vast in its extent, that theories of development which did bring organically remote links into close chronological approximation, would, for that very reason, be rejected as untrue.

The sudden appearance in cultivated plants of characteristics divergent from the parent stock, and capable of hereditary transmission has been deemed to supply valid arguments against Mr. Darwin's system, which involves the belief that important changes have, for the most part, been extremely slow; but facts of this kind, lessened in value by the well-known tendency of the offspring of varieties to go back to ancestral forms, do not give much help to account for the extent of change that has taken place, or for the expenditure of time which there is evidence to show actually occurred. Spasmodic geology might account for the disappearance of one race of creatures, and special miraculous interposition might be assumed as the cause of another race of creatures taking the place of those which had been summarily swept away; but if the advocate of such notions complains that Mr. Darwin does not show sufficient connection between the present and the past, it may be retorted upon him that palæontology exhibits more resemblances between the fauna and flora of distant periods than ought to exist upon an hypothesis of frequent cataclysms and fresh creations.

If Darwinism is to be proved inductively, it must be conceded that the transition from simple invertebrate to vertebrate forms, from one vertebrate form to another, has to be exhibited by facts not yet known to exist. If it is to be proved deductively, we must be in possession of biological laws not yet discovered; but no science progresses without theory, and the Darwinian theory is entitled to provisional acceptance until a more probable one appears. Experience and observation, however industriously carried on, do not suffice unless they are made upon a system, so that they affirm or deny definite propositions. A new and unexpected fact may occur in the experience of two men—one supposes it may be correlated with certain other facts, and makes observations or experiments to find out if this is the case; the other observes or experiments without any distinct purpose. The first may arrive at an important law, or generalization, while the latter can at best only increase our stock of disjointed facts. Mr. Darwin's hypotheses are certainly admirable aids to a philosophical method of inquiry; and if, notwithstanding the amazing amount of research displayed in his present work, he has not materially affected the probability pre-

viously attaching to his speculations, he has more fully shown the ground on which they stand, and suggested almost innumerable directions in which further inquiry must be made.

In another work which is to follow the present one, he proposes to deal with the variations of organisms in a state of nature; and in a third work, to try the principle of natural selection by ascertaining how far it will account for the entire group of facts brought together in his previous publications.

A large part of the present work is devoted to elaborate details not given in his "Origin of Species." The additional evidence of this kind is highly important, but the greater part of it is confined to a few groups of animals on which man has exercised his ingenuity from early historic times to our own day, such as dogs, horses, cattle, pigs, rabbits, and poultry, in which latter term we may shock fanciers by including pigeons. As domesticated dogs date back to the days when pre-historic races formed the well-known "kitchen middens," it is not astonishing that the origin of the animals should be exceedingly difficult to trace, and Mr. Darwin inclines to the belief that they have descended from several wild stocks, much modified by breeding and human selection. Different breeds of dogs would certainly have been taken for different species, if their bones only had come down for the anatomist to examine. Isidore Geoffrey St. Hilaire "has shown that in size some dogs are six times as long, the tail being excluded, as others; and that the height relatively to the length of the body varies from between one and two, and one to nearly four." Cuvier remarked that their skulls differ more from each other than those of any wild species belonging to the same genus, and there are differences in the number of their teeth. Within very moderate periods, great changes, capable of hereditary transmission, have been produced in breeds of dogs, and Mr. Darwin adduces some curious facts concerning the effects obtained by crossing. Thus, "Lord Orford crossed his famous greyhounds which failed in courage with a bull-dog—this breed being chosen from being deficient in the power of scent: 'after the sixth or seventh generation,' says Youatt, 'there was not a vestige left of the form of the bull-dog, but his courage and indomitable perseverance remained.'"

Dogs, pigeons, fowls, and horses afford instances in which man, by careful breeding and selection, has made amazing changes. Cats have not offered the same facilities, as "from their nocturnal and rambling habits, indiscriminate crossing cannot without much trouble be prevented." With pigs man has been extremely suc-

cessful in producing variations from wild types, and the figures which illustrate Mr. Darwin's book bring this fact very strikingly into view. No one can suppose that very long-nosed and short-nosed pigs would have been taken for the same species if their bones only had been known. Rabbits, again, show the power of domestication and selection in modifying the skull, the vertebræ, the ribs, the scapulæ, and other bones.

In the "Origin of Species," the variations in the structure and form of pigeons was much dwelt upon. In the present volume many fresh illustrations are given, and are followed by a series of important facts concerning domestic fowls, in the study of which Mr. Darwin has been valuably aided by Mr. Tegetmeier. Naturalists suppose the varieties of domestic fowl to be all descendants of the *Gallus bankiva*, though they vary in weight from one pound to seventeen, and differ, as every visitor to a poultry-yard knows, in the form of the skull, the plumage, the presence or absence of combs and wattles, and a host of other particulars. Abundance of supposed good species, founded upon osteological and other distinctions, would have been made of fowls, if their fossil remains only had been known.

It is exceedingly curious to pass from cases in which man has succeeded in producing great variation, to such an instance as that of the goose, in which comparatively little change has been made for hundreds of years.

The plasticity of some species of domestic animals, and the comparative fixity of others, is probably parallelled in wild ones, and natural causes must frequently isolate particular groups, and check promiscuous crossing in a manner analogous to the operations of man. It is evident also that different animals possess a widely varying amount of power of accommodating themselves to, or being influenced by changes in climate or other physical conditions.

Cultivated plants offer numerous instances of great change having resulted from artificial selection and cultivation, and afford very curious illustrations of some of the laws of variability. Thus, when Colonel le Couteur began his endeavours to raise new varieties of wheat, he chose the best ears, "but soon found that the grains in the same ear differed, so that he was compelled to select them separately; and each grain generally transmitted its own character." Wheat appears to exhibit considerable tendencies to variation, though many of the differences would not be noticed by common eyes. Thus, Professor la Gasca recognized "twenty-three sorts in a field belonging to Colonel le Couteur, supposed to be at least as

pure as any of his neighbours." Professor Henslow observed similar facts.

Maize appears to have afforded a very remarkable instance of modification produced by climate. A tall kind, brought from the warmer parts of America, and cultivated in Germany by Metzler, gave the following results: "During the first year, the plants rose twelve feet high and few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation, the plants were from nine to ten feet in height, and ripened their seed better. . . . In the third generation, nearly all resemblance to the original and very distinct parent form was lost. In the sixth generation, this maize perfectly resembled a European variety;" but "was distinguished by a somewhat more vigorous growth."

Peaches supply very interesting illustrations of variation. In the first place, there is considerable though imperfect evidence, that our peaches are descended from almonds, and numerous instances are on record of peach-trees producing nectarines; and Mr. Rivers has produced peach-trees from nectarine stones. "With respect to the more curious case of full-grown peach-trees suddenly producing nectarines by bud-variation (or sports, as they are called by gardeners), the evidence is superabundant. There is also good evidence of the same tree producing both peaches and nectarines or half-and-half fruit—by this term I mean a fruit with one half a perfect peach, and the other half a perfect nectarine."

The known variations of plants and animals of the same species from what would be deemed normal specific types are so great as to involve the definition of species in very grave difficulty. Where does variety end and species begin? Nor does the difficulty disappear by the introduction of such tests as sterility and fertility, for hybrids are not always sterile, as they ought to be, if the test were absolute, and both animals and plants have their fertility much affected by the conditions under which they live. In animals of the same species the periods of gestation are found to vary in different breeds, so that neither can this test be rigidly applied. It is obvious that as absolute sterility cannot be predicated of hybrids in general, comparative, or relative, sterility must be a very uncertain test of specific differences, unless some fixed degrees of these qualities can be agreed upon as sufficient to mark varieties and hybrids, and there does not seem to be any chance of such standards being determined. Mr. Darwin fully recognizes the importance of the fact that while crosses of varieties are often more fertile than their

parents, "crosses of species and their hybrid offspring are almost invariably in some degree sterile;" but he considers the hypothesis of Pallas probable, that "domestication eliminates the tendency to sterility, which is general with species when crossed." He adduces reasons for believing that our domestic dogs are descended from several wild species, and that the same is true of our sheep and our pigs. The latter are referred back to "at least two specific types, *S. scrofa* and *S. Indicus*, which probably lived together in a wild state in South-eastern Europe." He observes that "a wide extended analogy leads to the belief that if these several allied species, in the wild state, or when first reclaimed, had been crossed, they would have exhibited both in their unions and in their hybrid offspring some degree of sterility. Nevertheless, the several domesticated races descended from them are now all, as far as they can be ascertained, perfectly fertile together."

Domestication of animals causes them to be supplied with suitable food in appropriate quantity, and at regular times. It also leads to the preservation of good specimens, and the destruction of bad ones, and to defence from enemies of various kinds, and from inclement weather. Natural conditions must sometimes provide similar advantages, and might be expected to produce analagous results. Domesticated species and varieties appear more fertile than wild ones, and wild ones frequently lose their fertility under confinement. The numerous facts brought together by Mr. Darwin on these, and closely-allied subjects, are well worthy of profound attention; but we must pass on to another branch of his subject, the "Causes of Variability."

We naturally look to change of conditions as a probable cause of variation in offspring, and very instructive information on this subject is afforded by horticulturalists. Thus the doctrine that excess of food induces variability is supported by the statement of Messrs. Hardy and Son, of Maldon, that when they want to keep seed true, they grow it on poor land. In growing for quantity they employ rich land, and "sometimes have dearly to repent of it," because an unwelcome departure from the required type appears. Newly introduced flowers, it seems, do not vary for some time, but, in the course of a sufficient number of generations, varieties appear. Mr. Salter remarks, "Every one knows that the chief difficulty is in breaking through the original form and colour of the species, and every one will be on the look-out for any natural sport, either from seed or branch. That being once obtained, however trifling the change may be, the result depends upon

himself." M. de Jonghe, who has had so much success in raising new varieties of pears and strawberries, remarks with respect to the former, "There is another principle, namely, that the more a type has entered into a state of variation, the greater is its tendency to continue doing so; and the more it has varied from the original type, the more it is disposed to vary still further." Wild animals under domestication usually take time to vary, though not always. Thus the wild ducks in St. James's Park lost their true plumage after a few generations, but in the first generation the Australian dingos, bred in the Zoological Gardens, produced puppies marked with white and other colours. Mr. Darwin remarks that these dingos had probably been previously kept in a domesticated state by the natives; but with respect to horses in South America, Azara noticed that while wild specimens on the Pampas were always one of three colours, and wild cattle of a uniform colour, semi-domesticated animals of the same kind exhibited a great diversity of colour.

Crossing appears to have a variable effect, sometimes leading to new varieties, and at others to "atavisim," or the reappearance of some ancestral peculiarity not shown by the immediate parents.

Cultivators of flowers record their experiences of departure from the expected type in particular seasons. Thus in 1861 many varieties of rose "came so untrue to character, that it was hardly possible to recognize them," and similar instances are given of other plants. In such cases, meteorological conditions appear to have incited the variation.

The changes which we recognize may often be preceded by other changes that escaped our notice, and consequently are really less abrupt than they seem. Thus it has been observed that the cochineal insect only flourishes on its native kind of cactus, and will not thrive on the same species from other localities, or on a so-called native kind formerly introduced at Kew. The insect thus finds a difference not visible to man.

External conditions can only act upon capacities for variation possessed by plants and animals, and these capacities vary greatly in amount in different species; so that while some remain nearly unchanged under a great variety of circumstances, others are easily and quickly affected. Variation induced in one part is usually associated with variation in some other part, and such changes frequently determine whether or not the creature possessing them can live, or must perish under particular conditions.

We do not see that Mr. Darwin has carried us much nearer than

we were before to a perception of the fundamental laws of variation, though he has brought together an amazing amount of information, both as to the extent of known varieties, and the circumstances under which it has arisen.

To account for the remarkable phenomena of inheritance direct from parents, or, in the form of atavism, from remoter ancestors, he has devised the theory of "pangenesis," as he terms it, by modifying older notions on the same subject. This theory starts from the notion that every organized body is composed of cells—taking that term in a very wide sense—capable of reproducing their own sorts, and that special cells belong to each organ or part. An ovum or germ of the entire creature he imagines to contain a multitude of subordinate germs of its several parts, all the lineal descendants of similar gemmules back to the first parent of the whole lot. Ordinary reproduction on such a theory is the result of the development of such gemmules as can reproduce the parental type. Variation comes when other gemmules are brought more prominently into play. According to this theory, put forward as a "provisional hypothesis," "the child, strictly speaking, does not grow into the man, but includes germs which slowly and successively become developed, and form the man. In the child, as well as in the adult, each part generates the same part for the next generation. Inheritance must be looked at as merely a form of growth, like the self-division of a loosely organized unicellular plant. Reversion depends on the transmission, from the forefather to his descendants, of dormant gemmules, which occasionally become developed under certain known and unknown conditions. . . . . Finally, the power of propagation possessed by each separate cell, using the term in its largest sense, determines the reproduction, the variability, the development and renovation of each living organism. . . . . Each living creature must be looked at as a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in heaven."

We should certainly hesitate to accept this hypothesis, but it relates to a subject on which no rational explanation has been given. The "cell" is an indestructible entity. Deprive it of walls, of its apparent division into nucleus and surrounding plasma, it still crops up eternally. If we reject the notion that cells visible with a certain optical power are the formative agents in growth or reproduction, we are only driven to a plastic fluid in which higher powers might possibly discover minuter objects to which the term "cell"

would still be applied. Darwinically considered, everything that has hitherto been called a cell is a complex formation containing multitudes of cells. Each animal carries, in a cellular form, the descendants of all the varieties of cells of which all its grandfathers and grandmothers were made up. Such a theory must assume that every organ possessed by the most perfect animal of the present day must have had some sort of an ancestral representative in the earliest and simplest being from which the doctrine of development supposes it to have been originally derived. The cells forming the horns of the stag, or the eye of the man, must have had their ancestral representatives in the simplest form of organic life, supposed to have been the basis of the whole. To say that such a theory is astounding is certainly not to affirm its untruth, but many will rather agree to wait in acknowledged ignorance than accept suppositions so amazing, and resting chiefly upon bold conjecture.

We leave the matter here for the present, with great admiration for the extent of Mr. Darwin's research, and the skill with which he has unfolded one of the grandest and most important subjects on which the human mind can exercise its faculties. We do not, however, understand the statement of his concluding paragraph, in which he says :—"If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of organization, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and as a consequence to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything, and forms everything. Thus we are brought face to face with a difficulty as insoluble as is that of free will and predestination."

When we consider how very little of the universe we know at all, and how very imperfectly we know any part of it, we are not entitled to assume that the various steps by which a result is reached are not essential portions of one great scheme. The pre-ordination of a result does not necessarily render superfluous the particular law or method by which it is attained, and which we are just as much entitled to call pre-ordained as the result itself. No doubt natural history, as well as human history, which belongs to it, continually plagues us with the old puzzle concerning the existence of evil. The real solution of the problem is beyond our reach, but that is no reason why we should not trust the religious instincts which lead us to the conclusion "that all is well."

A DAY IN THE VICINITY OF SIMON'S TOWN, SOUTH AFRICA.

BY CAPT. G. E. BULGER, F.L.S., F.R.G.S., C.M.Z.S.

On a pleasant September morning, about three years ago, S—— and I left the barracks at Simon's Town, in Cape Colony, and ascended to the summit of the sandstone hills, which, close behind the town, rise to a considerable height above the sea, and form a sort of craggy wall round the narrow peninsula, whose extreme point is the far-famed Cape of Good Hope. On our left was the Simonsberg, the loftiest part of this mountain border; while, before and to the right of us, stretched a level plateau, strewn with broken rocks, and thinly covered with a stunted and ragged-looking vegetation of a dull greyish-green colour. A wander across the plateau to the sea beyond, and a peep at the birds and flowers which are to be found there, were the chief objects of our excursion; and amply they repaid us for our scramble up the cliffs.

The surface of the plateau consists mainly of white sand, with a sparse growth of greyish, rigid-looking shrubs and lesser plants, amongst which heaths, geraniums, pelargoniums, and proteas are the most prominent. The appearance of the whole is harsh and uninviting. There is an absence of verdure and softness; and the frequent patches of monotonous-looking sand, which peep out in all directions from amidst the thin wiry grass and straggling bushes, give the place a somewhat desolate aspect, in spite of the brilliant-hued flowers which here, as everywhere else in South Africa, are characteristic of the earth's covering.

On the slopes of the ascent I found many curious and striking plants, and amongst them, *Muraltia heisteria*, with its spiny, furze-like leaves; the *Kreupelboem*, or cripple-tree (*Leucospermum conocarpum*), so called from its ungainly and contorted branches; the strange-looking *Berzelia lanuginosa*, with its imbricated leaves and singular little heads of flowers; several species of *Polygala*; the *Scotia latifolia*, or "monkey boerboon" of the colonists; some *Diosmæ*; two or three kinds of *Rochea*; and *Rhus lucida*, on which the Cape mistletoe (*Viscum capense*) was growing luxuriantly. The beautiful *Diplopappus fruticulosus*, covered with myriads of charming little mauve-coloured, star-like flowers, and *Heterolepus decipiens*, also laden with bloom, were most abundant, and strikingly ornamental, relieving very gratefully the rather monotonous

uniformity of hue presented by the mass of *Mimetes*, *Serruria*, and other proteaceus shrubs, which, with heaths and coarse grass, make up the great bulk of the vegetation: though, here and there, the gorgeous scarlet corollas of *Leonotis leonurus* flash like meteors amidst the broken rocks and glittering sand. On the summit a kind of sheep's sorrel was tolerably plentiful; and the Rev. Dr. Brown, the colonial botanist, to whom I referred the specimens, kindly informed me that he believed it to be identical with our common English species, *Rumex acetosella*.

As we wandered on, fresh objects of interest continually met our gaze. In one place was a large patch of pale-coloured everlastings, their rigid flower-heads faintly rattling in the breeze, while a short distance further on, the yellow spikes of a species of *Satyrium* peeped up from amongst the coarse herbage. Presently we crossed a little foaming brook of dark-coloured water, dashing through a shallow ravine that crosses a portion of the plateau; and, from its grassy margin, started a fine hare (*Lepus capensis*), which scampered away to a group of rocks about a hundred yards distant. Near the edge of this little brook, we also met with about fifty or sixty small locusts, with black bodies, speckled with minute yellow dots, which were resting on the damp sand; and found two or three specimens of that beautiful, but common, and almost ubiquitous, butterfly, the painted lady (*Pyrameis cardui*). These, with the exception of a few beetles, were the only insects I noticed; though, doubtless, had my attention been drawn in that direction, I might have found hundreds of others.

Birds were tolerably numerous, especially the lovely yellow-breasted honey-suckers (*Cinnyris violacea*), and the "little stripe-heads"* (*Fringillaria vittata*), whose sweet, but weak, little songs were constantly breaking in upon the silence of the lonely plateau. A few wagtails (*Motacilla capensis*); sparrows (*Passer arcuata*); and doves (*Turtur semitorquatus*), were also to be seen amongst the rocks and bushes; while, overhead, some half-dozen swifts (*Cypselus leucothea*) were careering in the clear atmosphere. Now and then, a rock thrush (*Petrocincla rupestris*) flew past us; and last, not least, a pair of owls (*Strix flammea*) rushed forth from the shelter of a dark nook, where they had hidden themselves from the daylight, apparently much alarmed at our having discovered their retreat.

Lizards of many kinds were plentiful; and, amongst them, we found the curious black variety of *Cordylus griseus*, described by

* *Streepkopje* of the Dutch colonists.

Sir Andrew Smith in the "Zoology of South Africa;" but the others I did not attempt to identify, as they were common, and not of special interest to me.

During this pleasant ramble, I saw the handsomest *Helichrysum* I ever met with, and secured the only three blossoms which it displayed. They were somewhat oval in shape, small, and regular, and of the richest purple-crimson, reminding me of the colour of the Syrian garnet. The plant was between fourteen and twenty inches in height; the leaves sessile and linear, like those of the heaths, and the florets so lustrous that they glittered in the sun like polished metal. I did not recognize the species, and I regret to say that I lost my specimens, so that I was unable to refer them to some competent authority.

Many plants of *Leontonyx augustifolius* grew here amidst the "heather"; their aromatic, woolly leaves being very nearly as white as the sand in which they lived; and near them I found a strange orchis, which I had never seen before. The blossoms grew in a spike of about eight inches in height; and they, with the whole plant—leaves, stem, and even the roots—displayed a purplish tinge, resembling the colour of red beet-root; the inner whorl of the perianth deeper in hue, and of a more decided purple than the rest. I sent the leaves and flowers to the late Professor Harvey, who informed me that the plant was *Monadenia rufescens*.

* * * * *

In the afternoon, we walked to the circular battery along the beach. It was nearly low tide, and the beautiful white sand afforded us, consequently, better and firmer walking than usual. The air was almost cold, but very pleasant and bracing, while the fresh saline odour of the sea was delightful in the extreme. The walk was a somewhat wild and desolate one, and the silence broken only by the crash of the breakers on the silvery strand, and the deep *sough* of the receding waves, as they rolled back to the bosom of their kindred waters. On our left the sand-hills flanked the beach, rising to unequal heights, and robed with a thin sprinkling of protea, heath, and mesembryanthemum, with the white sand showing between the bushes in patches of various shapes and sizes.

We here saw a cormorant of some description, probably *Pelicanus graculus*, disporting himself on the very crests of the breakers, now sailing gracefully over the glancing water, and anon disappearing beneath the surface, in pursuit of the small fish and marine animals which constitute his food; and further out, almost

in the centre of the bay, was a crowd of gulls and petrels of various kinds.

The vicinity of the battery was gay with the flowers of the Hottentot fig (*Mesembryanthemum edule*), and the glowing scarlet blossoms of a species of *Morœa*, the latter visible, from the brilliancy of their colour, at a considerable distance.

The shadows of night were beginning to fall rapidly ere we returned to the barracks, delighted beyond measure with our day's rambling in the vicinity of Simon's Town.

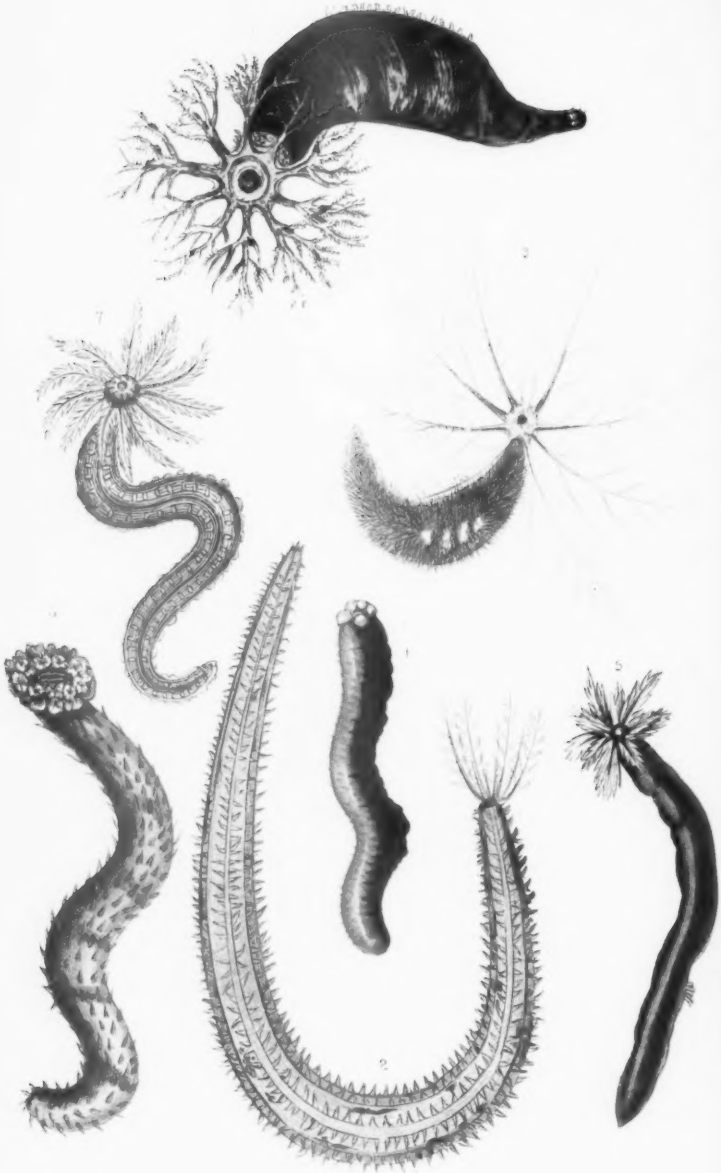
HOLOTHURIÆ; OR, SEA-CUCUMBERS.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

(*With Two Plates.*)

THE creatures which form the subject of our consideration in this paper are very interesting in many particulars. They are popularly known by the name of "Sea-cucumbers," from the strong resemblance some of the species have, when the tentacles are withdrawn inside the body, to the well-known vegetable. Another popular name with sailors and the lads of the sea-side of "Sea-puddings" is sometimes applied to these animals. The scientific name, *Holothuria*, is evidently from the Greek term ὁλοθούριον. It is always advisable to try to get at the meaning of the terms of scientific nomenclature, and to identify, if possible, the animals originally denoted by these terms, and the reasons for applying them; but this is often a difficult task. We meet with the Greek word ὁλοθούριον in Aristotle and other ancient natural history writers, but it is not clear what particular animal or animals were intended by the classic worthies of antiquity, who are generally vague and short in their descriptions. "Many animals," says Aristotle,* "are separate from each other, but incapable of movement, as oysters and the animals called holothuria." It is likely that the Greek word is derived from ὅλος, "whole," and θύριον, "a little door." Hence, from Aristotle's description, it is not improbable that the *Alcyonium digitatum*, with its numerous small polygonal depressions, may be denoted; or, it may be, the large, round, sponge-like alga, called Spongodium, living free on the sea-bed and abundant in the Greek seas. In the muddy bays of the coast of Lycia, Spratt and Forbes noticed many Holothuriæ, "mostly long, chocolate-brown species,

* "Hist. Anim.," i. 1 § 8.



HOLOTHURIÆ.

1.—Holothuria phantapus
2.—H. Sebæ.
3.—H. Scabra.
4.—Holothuria edulis.
5.—H. purpurea.
6.—H. Atra.
7.—H. Grisea.

having their heads garnished by twenty short tentacula, and very sluggish." The Holothuriæ were no doubt known to the ancient Greek fishermen, and it is very probable that they are the animals intended by Aristotle in the following sentence:—"Some experienced fishermen say they have seen in the sea creatures like pieces of wood, black, round, and of the same thickness throughout."* There is no evidence to show that they were ever eaten by the ancients, nor are they now by the modern Greeks, though we know various kind of Echini were highly prized as gastronomic dainties. But whatever animal was denoted by the Greek term ὁλοθούριον, the modern scientific name Holothuriadæ is well defined, and designates that family of cirrho-vermigrade Echinodermata, of which several British species occur on our own coasts.

Let us proceed at once to notice what is most worth recording of this family of Holothuriadæ, and consider (1) their general form and characteristics; (2) the localities where found; (3) their internal anatomy; (4) their curious power of reproducing lost viscera; (5) their classification; and (6) their utility, commercial or otherwise.

(1.) In their general form, Holothuriæ are more or less elongated, and sometimes vermiform; their bodies are furnished with numerous suckers, similar in form to those of the Echini and star-fish, arranged variously according to the genera, and used as organs of adhesion or locomotion. I have before me, as I write, two living species; we notice at the anterior end a circlet of yellowish arboriform tentacula, ten in number, arranged round the mouth; at the posterior end is another orifice, through which we may occasionally see water to be ejected. The body is very flexible, and capable of considerable extension and contraction. The circle of tentacles is often quite concealed within the oral aperture. The skin in the specimens before us is very tough, and reminds one of the coriaceous integument of the star-fish, to which we know the Holothuriæ are evidently allied. We observe five clearly-defined double series of these suckers running longitudinally along the body. In some species the suckers are scattered over the body with no definite arrangement, but generally the quintuple method obtains. In *Holothuria* (*Psolus*) *phantapus* (see Fig. 1) only three rows are developed, and these are placed on a soft disc or foot; two longitudinal furrows along the back indicate the obsolete suckers. Some of the Holothuriæ, as the species just mentioned, bear a resemblance to the Ascidian mollusca. *H. phantapus* has been described by Pennant

* "Hist. Anim.," i. 1 § 8.

under the name of *Ascidia rustica*. All the species have the power of changing their shapes: at one time they elongate themselves like worms; at another time, as in the case of a specimen now before me *H.* (*cucumaria*) *pentactes*, they blow themselves out with water, becoming almost globular, and looking ready to burst. Sometimes they contract the middle of their bodies, so as to "give themselves an hour-glass shape." The colour of these animals varies considerably, not only amongst different species, but amongst different individuals of the same species. In size they differ considerably, varying from three-fourths of an inch in length to a foot or more. Certain foreign species grow to a much larger size. The *Holothuria oceanica* of the Isle of Otaheite, described by Lesson (Fig. 7), attains the size of nearly four feet. The largest British species is the *H.* (*cucumaria*) *frondosa*, first observed by Forbes and Goodsir, in 1839, in the Shetland seas. As a rule, the Holothuriæ in confinement are inactive creatures, and, when their plumose tentacles are withdrawn inside the body, where they will often remain for days together, not very attractive in external appearance. Some kinds, however, are said to be exceedingly active.

(2.) Holothuriæ are found in mud, and amongst sea-weed in the sea around our coasts. Dredging is the most certain mode of capturing specimens, according to my own experience. It is very difficult to secure good specimens, for by forcibly dragging them from their places of attachment they get injured, and seldom remain alive more than a few days; they usually die with the tentacular circlet loosely extended.

According to the late Sir J. G. Dalyell, who paid great attention to the study of these animals—as indeed he did to a great number of the lower forms of animal life—the Holothuriæ show an extreme tendency to rupture: "Such an accident," he says, "whether external or internal, is particularly incident to larger specimens, and slight abrasion of the skin seems to be irremediably fatal. It does not appear that the rupture is confined to any part of the body, though frequently ensuing in the vicinity of the terminal orifice of the great cloaca. A prolapsus then follows, whereby the intestinal organs are discharged in large proportion. Sometimes the rupture is in the side of the animal, not far from the middle, where portions of the ovarium, almost mature, escape. An intestinal protrusion also sometimes ensues by the mouth, with rupture of the body." Those who have kept Holothuriæ in confinement, will bear out Sir John Dalyell's remarks, and all who have dissected the animals will share with him the surprise at seeing

such ruptures in integuments so strong, which are generally so "hard and tough, that an edged instrument can hardly pierce them." Most of the Holothuriæ are extremely susceptible when touched. A naturalist who accompanied Sir Edward Belcher during his voyage in the western seas, mentions a Holothuria with a soft, brown, tesselated integument, which on being touched—suddenly ejected the entire contents of its sacciform body, including the whole of the viscera and appendages—shrivelled up, and died. The reader will here be reminded of an analogous habit of some other Echinodermata which, when touched, immediately throw off their arms, and by a voluntary act of suicide seek to disappoint their would-be captors.*

(3.) We must now glance at the internal structure of these creatures. Some species differ slightly from others in this respect, but the following account, partly the result of my own investigations and partly that of others, may suffice to give a general notion of the internal anatomy of the Holothuria, though it must be confessed the functions of certain organs are not so certainly known as to preclude considerable doubts.

If we place a specimen of *H. pentactes* in a gutta percha trough, and fix it firmly down by two strong pins, one on each side of the collar, or part just under the mouth, and do the same by means of two more pins, one on each side of and a little above the posterior extremity, and then fill the trough with water, and place the specimen under one of Dr. Lawson's admirable dissecting microscopes, we shall be ready for our investigations. After noticing the beautiful circle of tentacles, we cut them off and put them away, in order to get a clearer view of the form and position of the mouth. This, we see, is simply a circular cavity, into which we insert the point of a pair of scissors and cut away—and hard cutting it is—through the tough integument towards the vent. Within the mouth are several white calcareous elongated plates forming a dental circle, which some consider to be analogous to the teeth of Echini. They are, however, very unlike the strong dental apparatus of their distant relatives, and seem incapable of any bruising power. "These plates," as Professor Rymer Jones remarks, "from their extreme friability, have been aptly enough likened to laminæ of dried paste; they may indeed in some slight degree be efficient in bruising food taken into the mouth, but it is more probable that they merely form points of insertion to the longitudinal muscles of the body, which, thus fixed around the circumference of the oral orifice, will

* As in Luidia, Forbes's "British Star-fishes," p. 138.

by their combination powerfully dilate that aperture for the purpose of taking in nourishment."*

Following our course past the dental circle, we come to a membranous tube, the œsophageal portion of the intestinal tract. This we can readily enough make out; the whole tract is nearly the same breadth throughout its entire length, presenting scarcely any appreciable stomachal dilatation; its course is tortuous, descending towards the posterior extremity, and then winding upwards again towards its commencement, again passing backwards and ending in a membranous cavity, the *cloaca*. The walls of the intestinal tract are connected by delicate mesenteric folds to the body. It is thus seen that the digestive apparatus of a Holothuria is of simple form, consisting of one long tortuous membranous tube, which commences close to the mouth, and, after several convolutions, terminates in a wide expansion near the anal extremity. In the intestinal tracts of the specimens I have personally examined, I have found no remains of food; it is said that sand, algæ, with debris of corals, are often found in the intestinal tract. The absence of any effective dental apparatus, and the inability of the tentacular coronet to grasp any prey, would, *a priori*, lead us to suppose that soft inactive animals, as various marine worms of easy digestion, which the Holothuriæ might capture on the mud, entered largely into their diet. The sand might be accounted for in this way, as being the remains of the cases of certain tubicular annelids. Nevertheless, the Holothuriæ have been known to swallow entire shells, for Tiedemann found several in the intestinal canal of *Holothuria tubulosa*, so that the animal matter must be dissolved in the shell and digested, the shells and other indigestible matter being rejected from the cloaca with the water in expiration.

Careful dissection reveals on each side of the body an elegant arborescent organ, commencing at the upper part of the cloaca, near the end of the intestine, by a wide opening, and leading to a membranous tube. This tube runs up towards the anterior extremity of the body, giving off numerous plumose branches. "One division of this elegant apparatus is maintained in close contact with the walls of the body by a series of delicate tendinous bands, while the other becomes applied to the convolutions of the intestines, wherewith it is likewise united. It is this last-mentioned division that would appear to be specially provided for the oxygenation of the nutritive fluids taken up by the intestinal veins." See Plate II. Fig. 7.

* "General Structure," etc., p. 246.

Notwithstanding the careful investigations of Tiedemann and Delle Chiaje, who differ considerably in their interpretations, there still exists much obscurity about the circulation of the blood in these animals, as in the Echinodermata generally. The subject is beset with great difficulty. According to Tiedemann, the nutritive portion of the food is taken from the intestine by the mesenteric veins, and conveyed with the veinous blood of the system by other vessels into the respiratory tree, from whence it is again collected by the bronchial veins, to be distributed through the great systemic arteries.

With regard to the reproductive organs in this family, recent investigators maintain that these animals, and other Echinodermata, are unisexual, and not hermaphrodites. At least, such is the opinion of Wagner, Peters, Müller, and Rathke. The ovary in the Holothuriadæ consists of a mass of long tubular appendages, which hang by their extremities downwards, and open above into a single excretory duct, being fastened to it like a brush. The oviduct, or the efferent vessel, lies along the anterior portion of the intestinal canal, and terminates near the anterior extremity of the body by a distinct opening on the dorsal surface. In the spring time, these long filamentary ovarian tubes become immensely distended with very minute ovules, which are suspended in a whitish, yellowish, or reddish fluid. The development of the Holothuriadæ has been studied by Hrn. Müller,* who has written an elaborate paper on the subject, and given numerous figures showing Holothuriadæ in their different stages. In their earliest stage the larvæ are somewhat flattened, with several ear-shaped lobes, resembling, as has been aptly said, a "coat of arms with its surrounding ornaments;" these young Holothurian larvæ are at first very small —in some species not more than eight-tenths of a line long. They are ciliated, and swim rapidly in a rotary motion, by means of their vibratile cilia. From the body being indented, and forming several ear-shaped lobes, the name *Auricularia* was given to these animals, it being at one time supposed that they constituted a new genus.

Fig. 1, Plate II., represents the second stage of a Holothurian larva, which has now assumed a barrel-shaped form, with five bands of cilia, and showing two calcareous wheels at its lower extremity. A more developed form is seen in Fig. 2, showing

* See his valuable memoir, "Uber die Larven und die Metamorphose der Holothurien und Asterien," in the "Transactions of the Berlin Academy," for 1849. See also an admirable paper by Professor Wyville Thomson "On the Embryology of *Asterocanthion*," in "Quarterly Journal, Microscopic Society," for 1861.

tentacles, calcareous ring surrounding mouth, intestinal tract, etc. A further development is seen in Fig. 4.

(4.) A very remarkable fact in the history of the Holothuriadæ is their power of reproducing lost viscera, to which allusion has been already made. On this subject the late accomplished Prof. Forbes remarks, "Sometimes the creature ejects all its viscera, or bursts the body with its convulsive contractions. It is usually stated that the Holothuriadæ do so whenever they are taken, but such is not the case. I have never seen the animal disgorge its intestines, but specimens of many species have I seen, in which there was not a trace left of the creature's bowels and other internal organs, though it seemed, when taken, alive and healthy. It is astonishing how long they can live deprived of the most essential parts of their organism. Sometimes they are found wanting the respiratory organs, and sometimes the generative tubes are deficient; and these deficiencies so frequently occur, that we should be extremely shy of proclaiming differences in the internal structure of species; and when we see genera and species (as has been the case) *anatomically* defined from the want of respiratory trees or genital tubes, we should be extremely cautious about admitting such, and rather regard such wants as accidental deficiencies in a few specimens than as organic peculiarities." *

At a meeting of the British Association, at Glasgow, in 1840, Sir J. G. Dalyell stated that he had observed certain species of Holothuriæ lose "the tentacula with the cylinder (dental apparatus), mouth, œsophagus, lower intestinal parts, and the ovarium, separating from within, and leaving the body and empty sac behind. Yet the animal does not perish. In three or four months all the lost parts are regenerated, and a new funnel, composed of new branches, as long as the long body of the animal, begins to exhibit the same peculiarities as the old one, though longer time be required to attain perfection. Other species of the Holothuriæ divide spontaneously through the middle into two or more parts, all becoming ultimately perfect by the development of new organs. Yet the anatomical structure of the whole genus is so complex, as to defy the skill of anatomists in discovering the proper functions of some of the parts." †

This voluntary ejectment of the internal organs seems the more surprising when we reflect how seriously even slight internal injuries affect the animals, and causes a prolapsus of their viscera,

* Forbes's "British Star-fishes," p. 199.

† "The Power of the Creator Displayed," vol. i.

which invariably terminates fatally. The voluntary ejectment of the viscera has been noticed by several observers. Of *Thyone papillosa*, Dr. Johnston gives the following account:—"The animal having been kept in sea-water unchanged for two or three days, sickened, and, by the more frequent involutions and evolutions of its oral end, evinced its uneasiness. Being left unobserved in this state for an hour or so, I found on my return that it had vomited up its tentacula, its oral apparatus, its intestinal tube entire, and a large cluster of ovaries which lay about the plate. The muscular convulsion must have been very great, which thus so completely embowelled the creature; and yet life was not extinct, for the tentacula contracted themselves on being touched, and the empty skin appeared by its motions to have lost little of irritability." Lost little of irritability, forsooth! Professor Rymer Jones amusingly remarks—"Had Dr. Johnston only waited long enough, he would have found that the animal was all the better for the gentle depletion; and having got rid of such troublesome trifles as its old viscera, was quite ready to begin the world again with a new set.

> 'The times have been
> That when the brains were out the man would die,
> And there an end!'

Not so, however, with our Holothuriæ. We have at this moment before us, in a jar of spirits of wine, wherein they have been quietly inurned during the last six months, the entire inside of one of these creatures—mouth, tentacles, alimentary canal, respiratory tree, ovarian tubes, and all; and yet, in yonder tank the animal itself, to which they once belonged, is creeping leisurely about his mimic rockery, apparently as well and active as if they still formed an integral part of his economy, and brandishing a new set of tentacula quite as complete as their predecessors."*

The texture of the skin in the Holothuriæ is very hard and tough, and the muscular system well developed. Five pair of muscles run the whole length of the body; they are separated by spaces, in which tranverse circular fibres are found, that cover the entire inner surface of the skin. By means of these longitudinal muscles, which are fixed round the circumference of the oral orifice (dental calcareous plates alluded to above), the body can be shortened and bent, while the transverse fibres contract it transversely, and thus elongate the animal. A microscopic examination of the coriaceous integuments of some of the Holothuriæ reveals the existence of a number of small isolated plates, pierced, like a

* "Aquarian Naturalist," p. 244.

sieve, with numerous holes; these, no doubt, are the representatives in this family of the solid calcareous plates of the Echini and other Echinoderms. Numerous apertures are distributed over the surface of the skin, through which the muscular feet or suckers are protruded. In some species these apertures occur all over the body, in others they are arranged in five series, reminding the observer of the *ambulacra* of an Echinus, and the relationship of that animal to a Holothuria. In the genus *Psolus*, as we have seen, three series of locomotive feet are placed on a flattened disc, upon which, slug-like, the animal creeps. The structure of the ambulacral feet of a Holothuria appears to differ in no essential particular from those of star-fish and Echini; and the mechanism whereby each fleshy foot is protruded and retracted is similar.

Moveable retractile hooks, which probably aid in locomotion and adhesion, occur in the integuments of some species. Some doubt has been expressed as to the presence of a nervous system in the Holothuria. Cuvier thought he could detect "a very attenuated nervous cord around the œsophagus"; but this is denied by Delle Chiaje. A circular nervous cord within the calcareous œsophagal ring, to which, as we have seen, the longitudinal muscles are attached, has been observed by Müller. This is confirmed by an excellent English authority. "In the Holothuria," says Dr. Grant ("Compar. Anat.," p. 184), "where the axis of the body is greatly lengthened, and the animal reclines and moves on one side of the trunk, like the higher classes; where the calcareous shell is wanting, and the muscular system is most distinct and powerful, the nervous system is extensively distributed, and begins to manifest an approach to the helminthoid type. Interior to the osseous apparatus of the mouth is a white nervous ring, around the œsophagus, from which nerves pass outwards to the large ramified tentacula around the mouth, and others extend upwards along the course of the eight [ten] strong longitudinal muscular bands. Fine white filaments are likewise seen passing inwards to the stomach and alimentary apparatus."

(5.) We have already seen certain intimations of the relationship of the Holothuriæ with some of the Echini and star-fish, and although at first sight there might appear to be nothing in common between the spherical sea-urchin, with its envelope of calcareous plates and bristling spines, the common cross-fish (*Uraster rubens*), with its stellate body and rounded rays, and the sea-cucumber, with its flexible cylindrical body, yet close inspection and a little reflection will convince us that all these animals are more or less distantly

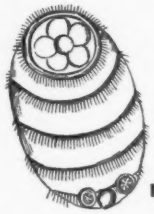


FIG: 1.

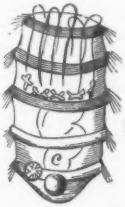


FIG:2.

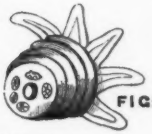


FIG:3

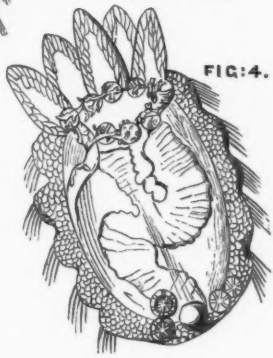


FIG:4.

FIG:6.

FIG:5.

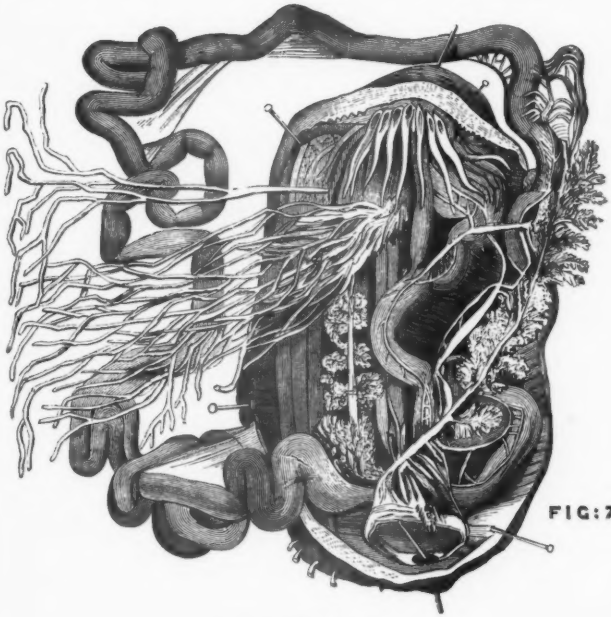


FIG:7.

DESCRIPTION OF PLATE II.

Figs. 1, 2, 3, and 4.—Holothurian larvæ in different stages of development.

Fig. 5.—Calcareous wheel-like plates from the skin of *Chirodota violacea*—a Mediterranean Holothuria.

Fig. 6.—A single "wheel," more highly magnified.

Fig. 7.—A Holothuria opened, showing tentacles withdrawn inside the body, tortuous intestinal tract, long generative tubes, respiratory trees, cloaca, and anus.

related, and are rightly regarded as belonging to the class called Echinodermata by the zoologist. The late excellent Sir John Graham Dalyell could not understand how creatures so apparently dissimilar in external form as a *Holothuria*, *Asterias*, and *Echinus* could be associated together under the common name of Echinodermata; and yet these different families are certainly allied, as Forbes has well said:—"Throughout animated nature, forms and structures merge into each other, and while the central groups of a type present its essential characteristics, the more distant families approach in appearance and habits to the members of some other great class of forms. This is equally true respecting small as well as large groups. Thus the class of Radiata [Echinodermata] before us presents examples at one extreme of animals truly symmetrical, and at the other of species which approach, either in general form or in their early life, to the Amorphozoa, the lowest of animal types. For example, while the first state of a Comatula is analogous to a sponge or a polypidom, the highest groups of Echinodermata are creatures resembling mollusca or annelida."* Space forbids our dwelling longer on this most interesting subject. Those who wish to appreciate the analogies which link together creatures of very different external form, should read and think carefully over the late Edward Forbes's Monograph of the British Echinodermata, together with Professor Rymer Jones's instructive chapter on the same class, in the first volume of his delightful "Natural History of Animals."†

Forbes divides the British Holothuriadæ into four families, as follows:—

I. Psolidæ, or Ascidian Holothuriadæ, animals approaching the mollusca in their form, and having a soft circumscribed disc, like the foot of a gasteropodous mollusc, on which the suckers are placed for progression.

II. Pentactæ, which have the suckers arranged in five regular rows, and are more or less angular in form.

III. Thyones, which have the suckers scattered all over the surface of the body.

IV. Synaptæ, in which there are no suckers on the body, the oral tentacula being the only representatives of those organs.

The same writer enumerates fifteen British species. Sir John Dalyell has figured and described two kinds not mentioned by Forbes, though he has some doubt as to the claims of *H. Scotica*.

* Forbes's "British Star-fishes," p. xi.

† Ibid, pp. 240—295.

Mr. Peach has given an interesting account of another Holothuria, called the "nigger" or "cotton-spinner" by the Cornish fishermen. The animal, as one of the names implies, is very dark; it is the only British species with twenty tentacula.

"This Holothuria is very common in deep water off the Deadman, in certain localities (rocky ground), and is called by the fishermen a 'nigger,' and at times a 'cotton-spinner;' it is held by them in great detestation, from its throwing out what they call 'cotton,' and from its slimy nature, and also because when the 'niggers' are numerous, and get into the crab-pots, it is very rarely that crabs or lobsters are caught, and therefore they kill all they come near with their knives, because they do not like to touch them. This is not wonderful, for their appearance is anything but prepossessing." We are told that, on being handled, they stain the hand light green, which colour is not easily washed out. Though the colour of the back of this species is generally dark, and almost black at times, yet all shades of colour, from sienna to rose-colour and delicate pink, occur. The tentacula, when viewed from the upper part, are club-shaped on the top, the club being placed on a foot-stalk an inch in length, which is retractile, and invariably of a lighter colour than the top. "When seen from the under side, they appear like the umbels of the elder, and are beautifully branched and tipped, much in the manner of the elder-flowers; indeed they might be mistaken for that flower, only the foot-stalk is so much thicker in proportion." Mr. Peach tells us these 'niggers" eat portions of dead fish, shells, etc. "I have reasons," he adds, "for believing Terebella. He found also in their intestines a *Buccinum incrassatum*, with portions of the animal in it, portions of Balani, Nullipora, etc." This Holothuria "is extremely irritable, and on being touched or disturbed, throws out a bunch of white tapered threads about an inch in length and one-eighth in thickness. These soon become attenuated, either by the agitation of the water or the coming into contact with something, and are drawn into very long threads of great tenacity; they stick to everything they touch. This small bunch is drawn into a large mass of threads, so small that the finest sewing-cotton is not equal to it, and is no doubt one of the means of defence provided for its preservation; for I have seen a crab so completely entangled in it as not to be able to move, and a fish only able to get away after a long struggle. If much irritated, they throw out the whole of their intestines. This is invariably the case after being kept in confinement two or three days; and even after they have done so they have lived three

days, and their tentacula performed all their offices, as if the animal was strong and healthy."*

Figs. 4, 5, 6, 7, Plate I., represent certain foreign Holothurids as drawn on a reduced scale from the plates in M. Lesson's "Centurie Zoologique." *Holothuria oceanica* (Fig. 7) was found by Lesson occurring abundantly in Mattaway Bay, Otaheite, in 1823. It can elongate itself to three feet, and contract to twelve or fifteen inches. An acrid and corrosive liquid lubricates the exterior surface, and produces intolerable itching, so that it must be handled with great caution; the South Sea natives show a manifest repugnance at its sight.†

(6.) The animal depicted (Fig. 4), is the edible Holothuria (*H. edulis*) or "trepang," Biche de Mer, long celebrated in Indian commerce, and still an article of extensive commercial value in some parts of the East, as amongst the natives of the isles of the Indian archipelago, Cochin China, and the Australian islands. Thousands of Malay junks, M. Lesson tells us, are fitted out each year to fish for this animal; the produce is taken to Canton, and sold, at an average, for about forty-five Spanish dollars per picul (= 133½ lbs.). Macassar is the great market for them, and it is said that about 8,330 cwt. are annually exported from thence to China. As many as thirty varieties are said to be distinguished in the Canton market, each variety being designated by different names. According to Mr. Crawfurd, the trepang is sometimes two feet long, and from seven to eight inches in circumference, but its ordinary size is about a span long and two or three inches in girth.

The quality and value do not depend on its size, but upon properties not discernible by those who have not had much experience in the trade. M. Lesson gives the following description of the form of the *Holothuria edulis*. "The *H. trepang* is cylindrical and slender, and about eight inches long. The surface of the body is slightly rugose, body undulating, covered with short scattered papillæ, without definite arrangement; the upper part of the body is of a dark smoky black, the lower part and sides of a pretty rose-colour, speckled with black specs. The mouth is oval, and surrounded by six or eight bundles of rounded floccose tentacles."

* See "Annals and Mag. of Nat. Hist." vol. xv., 1845, p. 171, with Plate.

† Fig. 3 (Plate I.) represents a specimen of *H. fusus* which, in the possession of Sir J. G. Dalyell, had regenerated its lost tentacula. Both *H. fusus* and *H. Scotica* are, I suspect, doubtful species. The figures are drawn on a reduced scale from Sir J. E. Dalyell's "Power of Creator Displayed."

M. Lesson states that he has often eaten these creatures, variously prepared, but never found in them any particular taste, disguised as they always were by the enormous quantities of spices and aromatics in which the cookery of the people abound. I may add, that a relative of mine, when in China, frequently partook of trepang, or sea-slug porridge. He thought the dish by no means a bad one." "On placing one of these curious creatures in a basin," says Sir E. Tennent ("Ceylon," ii. p. 557, note), "it discharged the contents of its stomach; first, streams of water, and then quantities of sand, small stones, and comminuted coral and shells, until it was reduced to a flaccid mass—again inflating itself to its original size by re-imbibing the water." Sir E. Tennent then quotes Mr. Brodie, who, speaking of the trepang, says that the Holothurias are picked up at ebb tide, and after being embowelled are boiled for two hours till quite soft, and then dried in the sun. The price on the spot is about three shillings and ninepence for 1000, and this quantity can be easily collected by two men during one ebb tide. Other species of Holothuriæ are used as food. The *Holothuria tubulosa*, Blainv., is eaten at Naples, and the *H. guamensis* by the Ladrone islanders.

A FUNGUS IN TEAK.

BY HENRY J. SLACK, F.G.S., SEC. R.M.S.

Some weeks ago, Mr. Charles Tyler, was kind enough to bring me a small piece of teak, damaged in a singular way. The main substance of the wood was of a deep rich brown tint, like that of burnt sienna, and did not appear to have suffered general injury, but it exhibited numerous white patches of a cottony aspect, in which the fibre had been more or less completely destroyed, and small cavities lined with cottony-looking threads. Upon examination as an opaque object with a two-thirds objective, the white patches appeared to consist of bleached woody fibre, and seemed quite continuous with sound fibres in which no particular change could be discerned. The cavities seemed to have resulted from the destruction of the fibre. Very little more information was gained by investigation with a half inch and a lieberkuhn. It still seemed as if the white patches had no connection with each other, and no fungoid threads could be discerned. The white fibres were so soft as to break with a touch, and a small portion was removed

with the point of a knife, placed in a drop of water covered with very thin glass, and examined with Beck's one-twentieth objective, the illumination being carefully managed with Ross's four-tenths condenser and 20° stop.

Immediately one of the projecting threads of very minute size gave indications of fungoid structure, and prolonged examinations extending over several evenings led to the result that in every case of examination with this power, and Ross's A and B eye-pieces, extremely delicate threads, more or less beaded in structure, could be distinctly made out, and discriminated from the cellular tissue of the wood.

Being desirous of getting further information on the matter, I applied to Mr. Carruthers of the Botanical department of the British Museum, from whom Mr. Tyler had received his specimen. Mr. Carruthers was kind enough to give me a larger piece, and likewise a piece of Scotch birch, coloured green, like the "green oak" of the Tonbridge Wells ware, with the fungus which used to be known as *Peziza æruginosa*, but which fungologists now call *Helotium æruginosum*, and is described under that head in Mr. Berkeley's "Fungology." Mr. Carruthers told me that he had examined the wood with one-fifth objective and ordinary illumination, and had not detected any fungoid growth, at which I was not surprised, as the power he employed was insufficient to do more than indicate a *possibility* of such a growth in some places. He also informed me that Mr. Berkeley had written on the subject in the "Gardener's Chronicle," and that he received the wood from Mr. Brisbane Neill.

On referring to the "Gardener's Chronicle" (1st Feb.), I found that Mr. Berkeley had been informed—misinformed as it turned out—that the wood had been soaked with sulphate of zinc, and laid down as a sleeper on an Indian railroad. Mr. Berkeley had not found the "slightest trace of fungus," but said the wood reminded him of "the curious decomposed fossil wood which occurs in Tasmania;" and he referred to an analogous case recorded in Sowerby's "English Fungi" (tab. 387, Fig. 10), where a specimen of similarly damaged deal is figured.

My next proceeding was to request information from Mr. Brisbane Neill, who kindly and promptly replied to my inquiries. This gentleman received the wood from Captain Mitchell, superintendent of the Government Museum at Madras. Captain Mitchell had previously mentioned some damaged teak which had been soaked in a zinc solution, and had been *intended* for a railroad sleeper; and when specimens of damaged teak arrived, it was

at first supposed that this description applied to them. Hence the error into which Mr. Carruthers and Mr. Berkeley had been led. In a subsequent letter to Mr. Brisbane Neill, Captain Mitchell, said, "The wood I sent is not the saturated wood, but is exactly in the state in which it was when cut down, and the whole tree was in the same state. The piece of wood was sent to me by the forest department to whom the tree belonged."

Furnished with this information, I made numerous observations on the damaged fibre in the specimen I received from Mr. Carruthers, and found mounting small portions in glycerine jelly was the best plan for minute examination. Fig. 1, A, represents a vertical and *radial* section of the wood, made by splitting it. The white matter and cavities appear irregular in form and direction. Fig. 1, B, represents a vertical and *tangential* section.* In this the white patches and cavities are seen to be nearly regular in shape, though not in size, and to conform to the curved lines taken by the fibre. Frequently the cavities have invaded vessels and medullary cells.

Fig. 1, A.

Fig. 1, B.

Turning special attention to the white fibres, I succeeded in many cases in detaching unmistakable though very slender fungoid threads, and examined them with the one-twentieth and A and B eye-pieces, powers about 1000 and 1400 linear. In a few instances, several rounded cells with minute dotted contents were likewise visible.

In removing the damaged fibre and exposing it to some pressure in a fluid under glass, for the purpose of examination, the original position of fine mycelium threads would of necessity be more or less disturbed, but I think their general distribution is in slightly meandering lines. The white patches of germinal matter (?) common in mycelium threads were sometimes irregularly scattered through the thin tubes, and at others collected together in bacterium-like forms. Specimens of this last are shown in Figs. 2 and 3, the latter being unusually large.

Fig. 2.

Fig. 3.

* A radial section shows the silver grain of wood occasioned by the medullary fibres crossing the perpendicular fibres of the wood. A tangential section cuts through the medullary cells, and they appear as in Fig. 4.

Thin sections of the wood made with Topping's machine (as made by Baker), were compared with fresh cut sections of sound teak from Bombay.

The damaged teak in thin slices is an extremely beautiful object, especially in those (tangential) vertical sections which show the groups of medullary cells thrust in between the ordinary fibres. The medullary cells are of an exceedingly rich colour, varying from a bright reddish brown to a deep red brown, verging upon black. The dotted vessels are mostly pale brown, and in some of the pits (apertures) a very minute dotted bacterium-looking structure can be seen. The longitudinal fibres between the medullary cells and dotted vessels are paler than in the sound teak, but there may be nothing in this, as different trees may vary in this respect, and in the intensity of the colouring matter in the medullary cells. This contrast between the white damaged portions of fibre, and the adjacent apparently sound portions, is less striking in thin sections than in the mass, and more or less decided indications of mycelium threads of slender diameter, may be seen throughout some slices with a one-fifth and C and D eye-pieces, and careful illumination. The fungoid threads are very much smaller than those in the piece of birch already alluded to, stained green by the *Helotium æruginosum*.

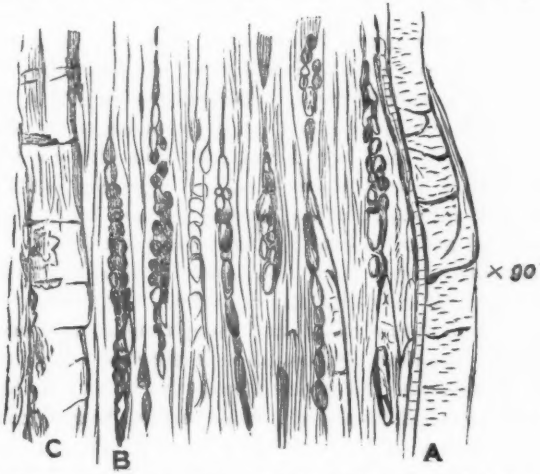


Fig. 4.—Section of damaged teak. (See description at the end of this paper.)

In one case, by splitting a piece of the wood in a vertical and tangential direction, I succeeded in tracing a good many white fibres, establishing a connection between what at first appeared

isolated cavities and white patches. These white fibres were not distinguishable from those in the cavities. They were wood fibres with (I suppose) mycelium threads accompanying them, similar to those detected in the cavities and white patches.

Mr. Berkeley on receiving a note from me, re-examined his specimen, and found "a few extremely delicate threads," not sufficient to account for the injury, and he remarked on the improbability of fungoid threads doing the damage in isolated spots, and not even changing the colour of neighbouring tissues.

I attribute my greater success in discovering fungoid threads, simply to my having used a one-twentieth instead of only one-fifth objective, aud having perhaps had an advantage with Ross's condenser. My belief is that the neighbouring tissues are not entirely unaffected, but that the fungoid threads have permeated the wood in various directions forming more developed groups in patches where perhaps the woody structure gave them greater facilities for growth. I have often seen similar threads amongst submerged moulds and mildews, and met with them repeatedly in investigating the vinegar plant, in various conditions and stages of growth. Whether such threads can belong to the mycelium of such a fungus as the Helotium, or any of its relations, I must leave an authority like Mr. Berkeley to decide.

That the injury done by bundles of minute fungoid threads should be great, no one who has noticed the oxydizing power of certain extremely slender forms of vegetation can doubt, and when a portion of a tree is in decay, it is far more likely that living organisms of some kind have something to do with its destruction than that it is a purely chemical action, as must, in the case of this teak, be supposed, if the fungoid threads I have succeeded in showing are not considered the agents of the change.

Mr. Berkeley very kindly sent me a small portion of the damaged deal referred to by Mr. Sowerby. The fibre seemed less damaged than in the teak case, and though mycelium threads were discernible, it was almost impossible to distinguish them from slight wrinkles, or folds in the woody tissue. So far as I could identify any objects as mycelium threads, they seemed larger than in the teak, and with less dispositon to take a beaded form. A piece of white wood in the condition known as "touchwood," also sent by Mr. Berkeley, gave similar results.

EXPLANATION OF WOODCUTS.

Fig. 1, A and B.—Portion of the teak. The white spots being

the damaged and bleached places. N.S. A, radial; B, longitudinal section.

Fig. 2.—Beaded threads lying on woody fibres. Mag. 1400.

Fig. 3.—Larger beaded thread. Mag. 1400.

Fig. 4.—Vertical (tangential) section of damaged teak. A, dotted vessel; C, ditto, partially broken; B, medullary cells. Mag. 90.

ASTRONOMICAL NOTES FOR APRIL.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

THE only planets suitable for evening observation during this month will be Venus and Saturn.

VENUS will be gibbous throughout the month. Each evening she will increase in apparent brilliancy, and be visible for a longer time; setting on the first day at 10h. 43m., and on the last day not until 11h. 46m. Her place in the heavens changing from R.A. 3h. 26m., N.P.D. 69° 19′, to R.A. 5h. 46m., N.P.D. 63° 24′, she will be always in the constellation Taurus, passing on the third day 2° or 3° to the south of the Pleiades, and on the 25th, about the same distance to the south of the bright star β Tauri. On the 26th she will be in conjunction with the Moon at half-past seven o'clock in the morning, and will therefore, early in the evening of that day, be conspicuous near the crescent, then but three days old.

SATURN becomes now well observable in the evenings. On the first day of the month he rises at 11h. 12m., and on the 30th as early as 9h. 10m. His path in the heavens will carry him during the month from very near ψ Ophiuchi, a star of the fifth magnitude, to about half-way between that star and ν Scorpii, a close double star, the components of which are of the fourth and seventh magnitudes. On the 10th he will be in conjunction with the Moon about seven o'clock in the evening, being then about 3° to the south of her.

Saturn's rings are this year very favourably situated for observation. The minor axis of the exterior ring exceeds in apparent breadth the diameter of the planet. A very good opportunity is therefore afforded for the study of those interesting appendages, the discovery of which was one of the first-fruits of the invention of the

telescope. Galileo indeed imagined that the planet was as it were threefold, having a smaller body on each side adhering to it; but Huyghens, in the year 1656, announced that the cause of the appearance was that the planet was "surrounded by a slender flat ring, everywhere distinct from the surface, and inclined to the ecliptic." This ring is now known to consist of several divisions; but particularly of three well-marked ones—a narrow exterior ring, called A; a broader and somewhat brighter next within, denominated B; and still within this a dusky semi-transparent ring, called C, which has been likened to a crape veil, and permits a faint view of the covered part of the ball of Saturn to be seen through it. This last has been much more recently discovered than the others. On the 25th of November, 1850, Mr. Dawes (whose death we have so recently to deplore) was, to use his own words,* "astonished at the appearance of a faint light extending over rather more than one-third of the interval between the inner edge of the bright ring and the ball." On November 29th the same phenomenon was observed. "There appeared to be a continuation of the breadth of the ring towards the ball, extremely faint, as if capable of reflecting very little light. A dark and rather sudden shading off was observed to form a boundary between this dull zone and the bright ring, the breadth of the zone being about two-thirds the breadth of the outer ring. At the interior edge of the ring, where it crosses the ball, a very narrow dark line was noticed, which became broader towards the east and west edges of the planet. I concluded that this dark line was the projection of the obscure zone, the full breadth of which is seen at the ansæ." Mr. Lassell, being on a visit to Mr. Dawes on December 3rd, saw, on the evening of that day, the same thing. The day after, they saw the announcement that Bond, at Cambridge, Massachusetts, had discovered an interior very faint ring of Saturn, and Dawes at once expressed his conviction that that view of the appearance was correct. It will, perhaps, be interesting to quote also the original observations of the Messrs. Bond concerning this discovery, as given by the father, W. C. Bond, at that time director of the Harvard College Observatory.† "The first diagram of the new interior ring of Saturn was made by G. P. Bond, on the night of the 11th of November, 1850. The memorandum in the note-book runs thus:—Nov. 11, 7h. 30m. We notice to-night with full certainty the filling up of light inside the inner edge of the inner ring of Saturn; also, what is very singular,

* "Astronomische Nachrichten," No. 751.

† Gould's "Astronomical Journal," vol. ii., p. 5.

where the ring crosses the ball, *below* the edge, there is a dark band, no doubt the shadow of the ring. But there is also a *dark line above* the ring very plainly to be seen, as there can be no question of the line where the ring crosses the ball. The light which fills the corners of the inner ring is suddenly terminated on the side towards the ball. The light does not arise, I think, from any optical cause, for I cannot see why the same appearance should not be visible on the outside of the ring, or indeed of any object which we look at. Am very confident of having seen to-night a second division of the ring near the inner edge of the inner ring." They again observed the new ring on November 15, and W. C. Bond thought he saw it clear of a connection with the old, but the side next the old not so definite as next the planet. The same evening (the definitions being remarkably good), G. P. Bond wrote, "Cannot be sure that the new ring is divided from the old one, but there can be no doubt that it exists. I did once or twice fancy, with the higher powers, that there was a division between the old and new rings."

When Dr. Galle, of Berlin, had seen these announcements, he* called attention to the fact that he had himself published, as early as the year 1838, some observations of an appearance like that of a veil (Schleier) adhering to the interior ring, and occupying half the space between that and the ball of the planet, which he, however, considered not as a separate ring, but as an extension of the interior ring. As he gave some very accurate measures of this appearance, he is generally thought entitled to being considered the first discoverer of the dusky ring, as it is now acknowledged to be. Search through ancient records has since shown that, many years before, appearances were noticed by several observers which must have been produced by the newly-discovered appendage. The first of these observations appears to have been made by Hadley in the year 1720.†

We must refer also to some very interesting observations of the dusky ring made by Mr. Lassell at Malta in the year 1852.‡ "One of the most striking attendant phenomena which I now note for the first time, is the *evident transparency of the obscure ring*. It is of a much lighter texture than the other parts, and both limbs of the planet can readily be traced through it. . . . . Notwithstanding the exquisite views I have had of the planet since my arrival here, far exceeding in sharpness of definition all I have ever

* "Astr. Nach.," No. 756.

† "Phil. Trans.," 1723.

‡ "Monthly Notices of the R.A.S.," vol. xiii., pp. 12, 13.

seen at Starfield, I have never obtained a single glimpse of the division in the ring C, seen and measured micrometrically by M. Otto Struve, nor of the ring being concentrally divided into two, as seen by Mr. Dawes. On every occasion, and when most sharply defined, it appears of one uniform texture and depth of shade, constantly conveying to my mind the idea of network on a crape veil, as I originally described it."

A curious observation by Mr. Carpenter, of the Royal Observatory, Greenwich, may be noticed here. It was made on the evening of March 26, 1863, and consisted in a "great increase of brightness of the dusky ring, which appeared nearly as bright as the illuminated ring, and might easily have been mistaken for a part of it."

The boundaries, changes, division, and amount of transparency of the dusky ring, also the division of the exterior bright ring, are matters calling for further examination by those observers who are provided with good instrumental means. With regard to the rings generally, Sir John Herschel remarks that all indications from observation point to a vaporous constitution. Physical considerations also make this probable, and "it is very possible that the rings may be gaseous, or rather such a mixture of gas and vapour as consists with our ideas of a cloud."*

Occultations of Stars by the Moon.—Only one of these is visible in the evening, that of k Virginis, a star of the 6th magnitude, on the 6th day of the month. Disappearance, 10h. 35m.; reappearance, 11h. 30m.; angular distance from the vertex to the right hand in inverting telescope, 9° and 281° respectively. Whilst this star is behind the Moon, another of nearly equal ($6\frac{1}{2}$) magnitude, 46 Virginis, will just escape occultation on the other side of the Moon, her limb passing, about 11h. 10m., within a very short distance of it.

The Moon.—The phases of the Moon, with notices of those regions of her surface, which will be at different times under or near the terminator, we have this month thrown into a tabular form. No new feature of particular interest has, so far as we know, been brought to light since the date of our last "Notes."

April 1. Plato, Eratosthenes, Mare Nubium.
„ 2. Mare Imbrium, Copernicus, Bullialdus.
„ 4. Kepler, Gassendi, Mare Humorum.
„ 5. Aristarchus, Galileo, Schickard.
„ 6. Grimaldi.
„ 7. Full Moon at 7h. 17m. A.M.

* "Outlines," § 518.

April 8, 9. Mare Crisium, Mare Fœcunditatis.
„ 14. Last Quarter at 10h. 35m. P.M.
„ 22. New Moon at 8h. 20m. P.M.
„ 25, 26. Mare Crisium, Mare Fœcunditatis.
„ 27. Posidonius, Mare Tranquillitatis, Theophilus.
„ 28. Mare Serenitatis, Maurolycus.
„ 29. First Quarter at 6h. 18m. P.M. Archimedes, Hipparchus.
„ 30. Mare Nubium.

APRIL METEORS.—An interesting group of meteors has established a claim to consideration for this month. Not long after the remarkable fact was proved, that the August and November groups move in orbits nearly coincident with those of two small comets, it was noticed, by Drs. Weiss and Galle, that the April meteors also followed nearly the path of a comet, known as I. 1861, which was discovered by Mr. Thatcher, of New York, and is supposed to have a period of 415 years.* But as the observations of that group were not very numerous, it was desirable to procure, if possible, some confirmation of this.

Last year, however, little additional information was obtained. Indeed, the only observations we have met with were made by Professor Karlinski, of Cracow, who saw nineteen meteors, chiefly of the first or second magnitude, between midnight on April 20, and three o'clock on the following morning. Of the nineteen, sixteen appeared to belong to the group, and they gave a radiant point, agreeing well with the observations of former years, at about R.A., 18h. 0m., N.P.D., $55\frac{1}{2}°$, or very near the constellation Lyra. If we assume that the earth crossed the orbit of the meteors last year about two o'clock Cracow, or one o'clock Greenwich, time, on the morning of April 21, it will follow that we shall this year cross it about seven o'clock on the morning of April 20. This may be somewhat in error, and it will be advisable to keep up a watch for a few hours before daylight on that morning, in the hope of observing a few meteors of the group, and improving our knowledge of its orbit.

THE NEBULA OF ORION.—An interesting paper by Professor D'Arrest has recently appeared in the "Astronomische Nachrichten," on the great nebula of Orion, which it seems desirable to give some account of here. He states that in the disputed question as to changes which have been said to have taken place in the

* See a paper by myself in the "Proceedings of the Meteorological Society," for 1867, April.

appearance of the nebula, a drawing made by Lefebvre, Professor of Physics at Lyons, in the year 1783, and published at Paris in the 22nd volume of "Rozier's Observations," has been overlooked. An examination of it throws doubt upon several of the supposed changes, as it delineates the parts of the nebula to which they refer in a manner very similar to that of the latest drawings of Bond and Struve. So that the variability would appear to be limited to some temporary changes of light at some nodal points, and the greater or less visibility of the faint patches of light which fill up some gaps, such as the Sinus Lamontii. The question of these changes has become of great interest since Mr. Huggins's prismatic analysis of the nebula has shown that it possesses a gaseous constitution. The variability of the faint stars within the trapezium appears to be well established. But further observation of the light of different parts of the nebula itself are very desirable. D'Arrest gives in the same paper some observations made by him of the branches of nebulous matter which connect the great nebula about θ Orionis with the smaller masses on each side of it, about ι and c Orionis. Thus θ and ι are connected by a double branch, and θ and c by a threefold branch. The system evidently extends still farther. But the examination of these minute points is very laborious, and can only be pursued on very favourable nights, and with very powerful object-glasses. Some of the branches mentioned were observed also by G. P. Bond, but were not figured by him, owing to his death shortly afterwards, which, it will be remembered, took place early in 1865, before he could receive the medal of our Astronomical Society, which had been that year awarded to him, in recognition of his important observations and discoveries.

THE NACHET ROTATING STAGE FOR THE MICROSCOPE.

At one of the meetings of the Royal Microscopical Society last year, Dr. Carpenter exhibited a binocular microscope, by Nachet, fitted with a rotating stage, which he highly commended. Acting upon Dr. Carpenter's advice, Mr. Henry Crouch (of London Wall), adapted this form of stage, with a slight improvement in its construction, to the instrument which he calls his "Cheap Binocular."

The Nachet rotating stage is very similar to the excellent pattern which the late Richard Beck—to whom microscopy was so

deeply indebted—constructed for his well-known "Popular Microscope," but it differs in some particulars. The accompanying sketch will render its construction and action intelligible. C is a plate of thick black glass, set in a brass circular frame, with a milled edge. A slight pressure upon the milled edge causes the

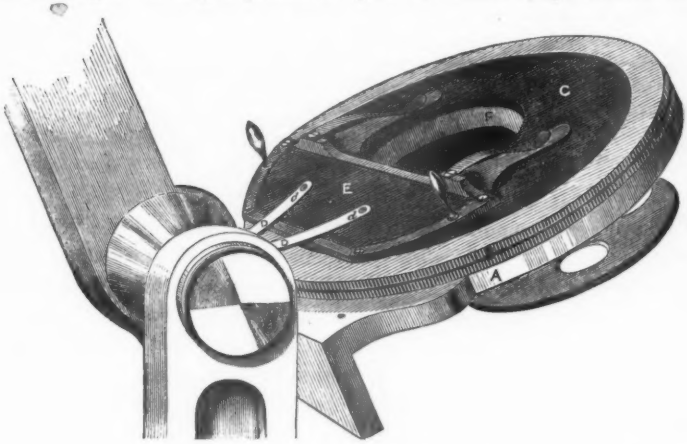


plate and object to rotate very smoothly and concentrically with the optic axis of the instrument. The object-holder is formed of another piece of smooth polished black glass, (E), carrying a brass frame on which the object is laid. Two brass springs, *d d*, with smooth ivory points at their extremities, press the glass plate, E, against the stage plate, C, with sufficient force to keep it steady when carrying ordinary objects or apparatus. The two upright brass handles enable the plate, E, to be slided in any direction with a very equable and agreeable motion, and with sufficient adhesive resistance to ensure steadiness. The extent of motion is determined by the brass frame of the plate, E; the motion stops as soon as the ivory points come into contact with the frame in any direction. The amount of motion is abundant for slides, etc., but is not quite enough when zoophyte-troughs are used. While, therefore, thoroughly agreeing with Dr. Carpenter in estimating very highly the convenience of this kind of stage, we have suggested to Mr. Crouch the propriety of adding a trough-holder, which will very slightly increase its expense.

We congratulate Mr. Crouch upon having now produced one of the most complete and scientifically constructed of the cheap microscopes. He has done well in adapting it on Beck's plan to

carry all the illuminating apparatus usually required, and in providing it with the universal screw.

Ross's new instruments and apparatus fit the same guage as Beck's. Crouch wisely takes the same sizes, and we hope soon to have an universal guage for apparatus as well as for the screws attached to powers.

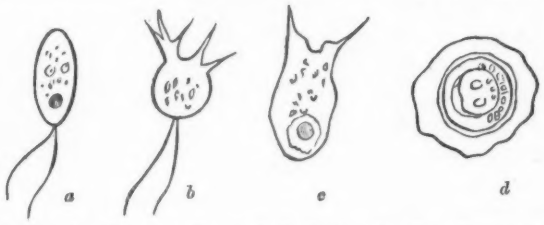
NOTES FROM PROFESSOR HUXLEY'S LECTURES AT THE COLLEGE OF SURGEONS.

BY E. RAY LANKESTER.

We have heard some persons ask, "What is the good of attending lectures? Cannot you learn everything you will hear much more effectively by reading at home?" In very many cases, no doubt, it is true that lectures are not what they should be; but such lectures as those which a master in science can give are worth many books. It is because Professor Huxley possesses two great qualifications that his lectures are now so numerously attended, and so deservedly esteemed: he is a most original thinker and brilliant observer, and perhaps what is more important, he keeps himself thoroughly acquainted with the work done in his departments of science in Germany, France, and elsewhere, and thus is able to give in his lectures the latest results of thought. It would be impossible, in a brief space to give a report of the lectures which Professor Huxley has delivered this spring at the College of Surgeons on the Invertebrata, but we may notice a few points of novelty or interest which have been discussed. The Invertebrata are regarded by Professor Huxley as very sharply cut off from the Vertebrata. There are no links which connect the two in any way; the bi-cavitary structure and the notochord of the Vertebrata is not approached by any member of the other groups of the animal kingdom. At the same time, the Invertebrata do not form an assemblage equivalent in value to the Vertebrata, but contain many such assemblages. On the other hand, when we examine the lowest members of the Invertebrata where they approach the kingdom of plants, we find no such sharp line; in fact, it seems impossible to erect a definite boundary. The points which separate undoubted plants and animals, are sufficiently numerous. The plant has a cellulose investment to its cell, does not exhibit locomotive * or con-

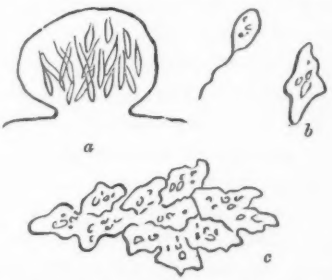
* Professor Huxley must have spoken these words unadvisedly, as the motile zoospores of undoubted plants abundantly show.—Ed.

tractile organs, and never takes solid nutriment; and plants alone can form vital matter from mineral forms of carbon, hydrogen, oxygen, and nitrogen. Animals are in all these matters the reverse of plants. But amongst the doubtful forms we find organisms agreeing in some things with plants and in others with animals. Cienkowski has recently (1865) been studying the Monads; those minute animals with a vibratile filament at one or both ends of their bodies, so common amongst decaying organic matters. Professor Cienkowski shows that these organisms pass through an animal and a vegetable condition. A Monad such as *a* (*Pseudospora*) passes

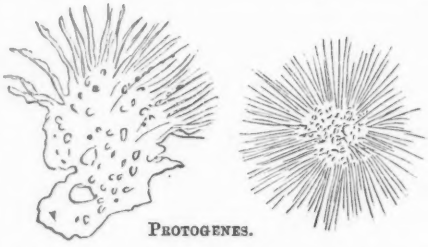


into the Amœba-form, *c*, through *b*, losing its flagellum; then, after feeding as an Amœba, and creeping about for some time, it assumes the encysted form, *d*, becoming invested with a *cellulose* sheath, and often acquiring a chlorophyl or plant-green colour. This form, *d*, after some time splits up into four or more parts, each of which becomes such a Monad as *a*.

The form called Myxomycetes presents another example of dubious nature. These growths are found on the surface of tan-pits, and on old trees and wood generally. They have very generally been set down as "fungi," but their investigation by de Bary shows that this view cannot be unhesitatingly taken. On the surface of the slimy masses which these growths form, little projections like minute puff-balls appear, and become filled with spores, *a*. These spores being set free by the bursting of their capsule, give rise to innumerable Monads, and these again to Amœba-forms, *b*, which for some time lead an animal existence; but presently, if they fall in a suitable *nidus*, numbers of these Amœbæ aggregate, and fuse into masses, *c*, as large as your hand, in which state they form incrusta-



tions, and actually move *en masse* (as in *Œthalium*). It is from these incrusting masses that the puff-ball-like capsules arise, developing from the *plasmodium* as the viscid substance has been termed. Though in their Amœba-condition, these organisms have been observed to take in solid food, Professor Huxley thinks that the mode of reproduction places them decisively amongst plants. A third case, which is perhaps more puzzling than any, from its absolutely negative character, is the organism called by Professor Haeckel *Protogenes* (1865). This is simply a minute drop of living jelly, far simpler than even a white blood-corpuscle, having no nucleus, no contractile vesicle, "no nothing," in fact, except the property of flowing in various directions, and of protruding innumerable fine processes or pseudopodia, which are very efficient in seizing and engulfing anything nutritious, the act of deglutition consisting, as in the Amœba, of a pouring of itself over its food on the part of the *Protogenes*. Professor Huxley remarked upon the blow that this discovery gave to the speculations of cell-theorists, and even to views of the mysterious power of nuclei. Here is a living being absolutely devoid of structure, that is to say of any structure excepting molecular structure. Its existence proves life to be a molecular property, and that organization is the product of life, not life the product of organization.



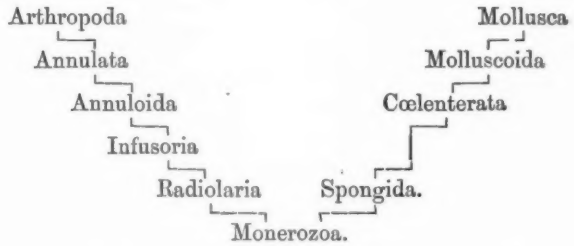
PROTOGENES.

Professor Haeckel, of Jena, in a very remarkable work, the "Morphology of the Organism," published a year since, has proposed a sort of no-man's land, neither plants nor animals, for the dubious forms. He calls them Protista, and gives the following groups: 1. Moneres (*Protogenes*, etc.); 2. Protoplasta; 3. Diatomea; 4. Flagellata (*Monads, Euglenæ, Volvox*, etc.); 5. Myxomycetes; 6. Noctiluca; 7. Rhizopoda; 8. Spongiada. Professor Huxley does not approve of this plan at all, as a new difficulty of definition is added by the new kingdom. He would place the Diatomea with plants, as also the Flagellata and Myxomycetes. Noctiluca is undoubtedly a highly-organized animal, whilst the Protoplasta, Rhizopoda, and Spongiada are animals, and with them goes Protogenes, though this gives, if any organism does, an intermediate and debateable ground.

Protozoa.

1. Monerozoa—
   a. Protogenes, *β*. Foraminifera, *γ*. Amœboidea, *δ*. Gregarinida.
2. Radiolaria—
   α. Thalassicollæ, *β*. Polycistina.
3. Spongiada—
   a. Halisarcidæ, *β*. Clionidæ, *γ*. Spongidæ, *δ*. Petrospongidæ, *ε*. Tethyadæ.

The above are the groups and arrangement which Professor Huxley now adopts in the Protozoa, but he considers them very transient and unsatisfactory assemblages. In speaking of the classification of the Invertebrata generally, three distinct sorts of classification were pointed out as possible, a logical, a gradational, and a genetic; the last is the only resting point for our efforts at natural classification. The following scheme was exhibited as a gradational arrangement of Invertebrata—not necessarily involving the hypothesis of genetic relationship as explanation, but simply and truly indicating bare fact:—



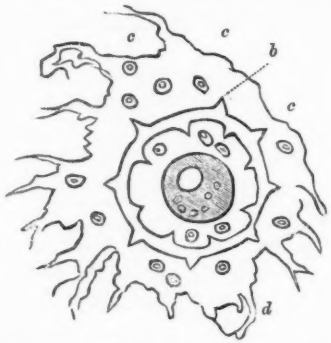
The Foraminifera (a group of Monerozoa) were discussed at considerable length; they were described as little more complex than Protogenes, but capable of forming either a horny, a calcareous, or a built-up shell, in some forms quite simple, but in others, by aggregation of simple chambers, forming most complex structures. There appears to be no possibility of distinguishing species or even genera in Foraminifera, so complete are the gradations of form; only a few "types" can be pointed out. Professor Huxley expressed his belief in *Eoozoon*, which he compared with the recent encrusting genus *Carpenteria*.

The Amœbæ (whose general character all microscopists know) multiply by fission, and present an *approach* to sexual multiplication. An Amœbæ becomes quiescent, perhaps encysted, when its nucleus splits into several pieces, each of which, being surrounded by a little

of the parent Amœba's sarcode, is set free as a new and very small Amœba. Professor Huxley doubts if the contractile vesicle has a permanent opening in these creatures.

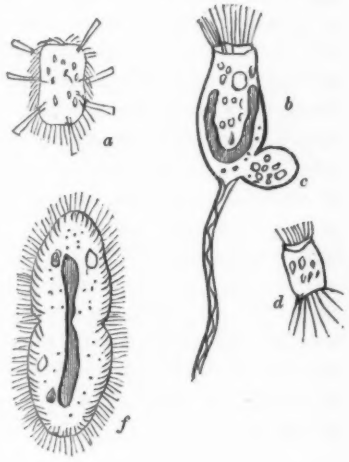
The encystation and formation of pseudo-naviculæ in *Gregarinæ* resembles the process in Amœba; but as there are often two *Gregarinæ* in one cyst, it presents analogies to the conjugation of Algæ. The *Gregarinæ* have no pseudopodia and no sac or cuticle, the cortical substance is simply denser than the deeper matter which contains the granules.

The *Radiolaria* are known to microscopists in England by the beautiful siliceous shells of Polycistina from Barbadoes. The Polycistina are the simple, the Thalassicolæ the compound or aggregated forms. The fresh-water *Actinophrys* or sun-animalcule perhaps connects these to the Foraminifera. Ernst Haeckel, in 1862, published a most beautiful work on the group, in which he showed what their characteristic structure was. A mass of sarcode-substance capable of extruding pseudopodia, *d*, contains in its centre a sac, *b*, this sac has a nucleus and granules within, and sometimes crystals of lime. Scattered in the sarcode-substance are numerous yellow cells, *c c*, which Professor Hæckel regards as having a liver's function. Besides this there may be a siliceous skeleton embedded in the sarcode, sometimes only a few spicules, at other times of great beauty and elaboration. Professor Huxley was himself the first to draw the attention of naturalists to the large floating forms which he called Thalassicolla, and which have the same essential structure.



With regard to the Infusoria some new statements were made which are of interest. A distinct cuticle must be admitted to exist in them continuous with their cilia, though in the Amœbæ and Gregarinæ such a structure is not recognizable. The latest researches of Stein (who has published a second great folio) and others, still leave the cause of the rotation of the food in the semi-liquid body-cavity unknown; but it is suggested that a cause similar to that operating in the circulation in plant-cells is at work. A distinct anal aperture has been recognized in many Infusoria; it is visible only when in use. The contractile vesicles have a permanent direct

communication with the surrounding water. The idea that Infusoria are "unicellular" animals must be abandoned, for the researches of Müller, Claparède, and Balbiani, have shown that the so-called nucleus and nucleolus, play respectively the parts of quasi-ovary and testis. Balbiani thought that when two Infusoria became conjoined, the testis or nucleolus of each changed over to the other. Stein, however, denies this; he states that there is no exchange, but merely an apposition which acts as a stimulus to the growth of the ovario-nucleus. This body then splits up into several segments, each of which becomes an embryo Infusor, presenting the larval *Acineta-form*. The *Acineta-form* is characterized by the sucker-like pseudopodia, which are also found in the unciliated adult genus *Acineta*. The connection between *Vorticella*, *Podophyra*, *Acineta*, and *Actinophrys*, which Stein at one time maintained, he now abandons. He has, however, made a very interesting observation as to the sexual forms of Vorticella. No one had ever detected a male Vorticella, *i.e.*, a Vorticella with a nucleolus or testis, only the great crescentic nucleus was seen, as shown in *b*. Professor Stein believes that just as the sexual conjugation of *Paramœcium*, *f*, was at one time mistaken for a process of budding or fission, so here the bodies like *c*, which have been called buds, are really the male Vorticellæ, which swimming freely as at *d*, attach themselves to the stalked females, and are gradually and completely absorbed into her. This conjunction of two individuals originally born separate is of great interest, appearing as the normal condition in Infusoria. Amongst the worms there is a remarkable example, the *Diplozoon*, and also the *Sphærularia*, the latter parasitic in humble-bees, in which something of the same sort occurs.



ON THE NEW THEORIES IN CHEMISTRY.

BY F. S. BARFF, M.A. CANTAB., F.C.S.,

Assistant to Professor Williamson, F.R.S., University College.

No. II.

If the air be exhausted from a vessel capable of containing 11·2 litres (the weight of the vessel being known and balanced by a counterpoise), and if it be filled with hydrogen at the normal temperature and pressure, *i.e.* zero, centigrade, and 760 mm. of mercury pressure, it will be found to weigh one gramme, that is, the weight of the hydrogen which has taken the place of the air will be one gramme. If the hydrogen be withdrawn, and oxygen made to take its place, the oxygen will be found to weigh 16 grammes; and also 11·2 litres of nitrogen weigh 14 grammes; the atomic weights in grammes of those elements which are gases or can be vaporized will, in the gaseous state, occupy a volume of 11·2 litres; but the molecular weight of compounds taken in grammes will occupy 22·4 litres, because their molecules occupy two volumes. It is useful, therefore, to take the atomic volume as 11·2 litres, as it simplifies calculations. For example, if it is desired to know how much chlorate of potash will be required to furnish 50 litres of oxygen, it is only necessary to divide 50 by 11·2, this will give the number of atomic volumes, and that number multiplied by 16 will give the *weight* of oxygen required, and the weight of chlorate necessary to yield this quantity can be found by multiplying the molecular weight of chlorate of potash by the found weight of oxygen, and dividing by the weight of oxygen contained in a molecule of chlorate of potash. The molecular weight of chlorate of potash $KClO_3$ is—

$$K = 39 \quad Cl = 35{\cdot}5 \quad O_3 = 48 \quad 39 + 35{\cdot}5 + 48 = 122{\cdot}5$$

$$\frac{16 + 50}{11{\cdot}2} = 71{\cdot}42 \left\{ \begin{array}{l} \text{grammes of oxygen in 50} \\ \text{litres.} \end{array} \right.$$

$$\frac{71{\cdot}42 + 122{\cdot}5}{48} = 182{\cdot}268 \left\{ \begin{array}{l} \text{required weight of} \\ \text{chlorate of potash.} \end{array} \right.$$

Similar calculations will give the quantities to be taken of any substance or substances for the production of a required volume of any gas; as, how much zinc and sulphuric acid must be used to

make 100 litres of hydrogen. It will not be necessary to work this out, as it would be almost a repetition of the preceding example.

A further confirmation of the correctness of the atomic weights of the elements now in use, has been obtained from their specific heats. It is known that, when equal weights of different substances are heated to the same temperature, they do not cool with equal rapidity; one body has required less heat to raise it to a given temperature than the other, and it therefore takes less time to lose that heat. If a pound of mercury be heated to 100° C., and be then mixed with a pound of water at 0° C., it will only raise the temperature of the water 3°, and the temperature of the mercury will fall 97°; therefore to raise one pound of water from 0° C. to 100° C. will require rather more than thirty-two times as much heat as is required to raise one pound of mercury to that temperature, and, as the times which equal weights of different bodies require for cooling through the same range of temperature are directly as their specific heats, the pound of water will take three times as long to cool as the pound of mercury. Of all known substances, water requires, for equal weights, the greatest amount of heat to raise it to a given temperature; it is therefore taken as the standard. The quantity of heat which any substance requires to raise it one degree centigrade, as compared with the quantity of heat required to raise the same weight of water through the same range of temperature, is called its specific heat; and as water requires for this purpose thirty-two times as much heat as mercury, if the specific heat of water be taken as 1, that of mercury will be as 1 : 32 approximately; the specific heat of mercury, as determined by M. Regnault, is 0·03332. Messrs. Dulong and Petit found that, if instead of equal weights, weights in proportion to the atomic weights of different substances were taken, the same quantity of heat was required to raise them to the same temperature. Thus, 200 parts of mercury and 118 parts of tin will, under the action of the same quantity of heat, be raised to the same temperature, and the specific heat of mercury multiplied by its atomic weight will give nearly the same number, as will the atomic weight of tin multiplied by its specific heat. The atomic weight of mercury is 200, and its specific heat 0·03332—

$$200 \times \cdot03332 = 6\cdot664.$$

The atomic weight of tin is 118, and its specific heat 0·05623—

$$118 \times 0\cdot5623 = 6\cdot63514.$$

Dulong and Petit therefore deduced the law that, *the specific heat of*

an elementary body is inversely as its atomic weight, so that all atoms have the same specific heat. In determining specific heats, the sources of error are so numerous that it is difficult, if not impossible, to attain to perfect accuracy, and therefore the products obtained by multiplying the atomic weights of elements by their specific heats do not always give exactly the same results; still they are sufficiently near to determine between two supposed atomic weights of any element, as, for example, it is clear, judging from this point of view, that the atomic weight of mercury cannot be 100, as was formerly asserted, or that that of phosphorus is not 62, as its vapour density seems to require, although the product of its atomic weight multiplied by its specific heat, does not give the exact constant 6·666; but comes somewhat below it—

$$31 \times \cdot18949 = 5\cdot87419;$$

it is, however, much nearer than if 62 were adopted as the atomic weight of phosphorus. Under the old system of atomic weights, some elements had only half the atomic specific heat of others (the atomic specific heat being the product of the multiplication of the specific heat by the atomic weight). Thus, bromine and iodine, in the solid state, gave respectively 6·744 and 6·8732 as their atomic specific heats, whereas, iron and zinc gave 3·1861 and 3·1054. Two examples only from each class are given here, as sufficient for illustration; a reference to the tables of the different atomic weights in any treatise on chemistry will show all the cases in which the difference occurs. The atomic specific heat of iron, as above quoted, is obtained by multiplying its specific heat by 28, thus:—

$$\cdot11379 \times 28 = 3\cdot1861.$$

28 was the old atomic weight of iron, whereas that now used is 56, and it, multiplied by the specific heat of iron, gives a near approximation to the constant 6·666—

$$56 \times \cdot11379 = 6\cdot3722.$$

And a similar result is obtained in the case of zinc; its specific heat multiplied by its old atomic weight gives an atomic specific heat of 3·1054—

$$32\cdot5 \times \cdot0955 = 3\cdot1054$$
$$\text{and} \quad 65 \times \cdot0955 = 6\cdot2108.$$

65 therefore is adopted as the present atomic weight of zinc. The evidence thus obtained, added to what is afforded from other sources of a nature similar to that alluded to in the early part of the first

article, shows clearly the necessity there was for doubling the atomic weights of certain elements, such as oxygen, sulphur, tin, and others whose compounds could not be accounted for rationally on the old system, and which were exceptions to what seemed so universal a law as that which we have just been considering. There are, however, some exceptions to it in the case of carbon, silicon, and boron. The specific heat of diamond is 0·1468; of graphite, another form of carbon, 0·2018; and of wood charcoal, 0·2415: these multiplied by 12, the atomic weight of carbon, give different atomic specific heats. Sir B. Brodie made experiments which lead him to form the conclusion that graphite acts the part of a separate element, forming a series of compounds in which it had an atomic weight 33. This multiplied into the specific heat of graphite, 0·2018, would give the constant 6·666 nearly—

$$\cdot 2018 \times 33 = 6 \cdot 6594.$$

However this may be, all these three elements exist in different states, which are termed allotropic modifications, and in each the specific heats of the several modifications are different; nor is it difficult to understand why this should be so, since the aggregation of the particles in each case is so different, and the bodies themselves show such different properties, that it seems natural to conclude that Sir B. Brodie's view with respect to graphite may, at some future time, be found to hold good with respect to the other elements, boron and silicon, in their modified states, and that in each they will be found to play the part of separate elements. Compounds obey the same law as elements as regards their specific heat. M. Wœstyn found that the molecular weight of a substance, multiplied into its specific heat, will give some multiple of the constant 6·666, and the number of times which it is contained in the product will represent the number of atoms contained in the molecule. This last fact enables us to determine the atomic weights of gases. Suppose it is desired to find the atomic weight of chlorine: if tin be dissolved in hydrochloric acid, a salt will crystallize out, the specific heat and molecular weight of which can be determined by experiment; its specific heat will be found to be 0·0939, and this multiplied by 189, its molecular weight, will give the product 17·7471; dividing this by the constant 6·666, the quotient will be 2·662; and as a fraction of an atom can take no part in a compound, the number of atoms being more than two must be three. As the atomic weight of tin is known to be 118, the difference between it and 189, the molecular weight of the chloride, will be 71; and

as in the compound there is but one atom of tin—for if there were more its molecular weight would be higher than it was found to be—there must be two atoms of chlorine; and therefore the atomic weight of chlorine will be $\frac{71}{2}$, that is, 35·5, and the formula of the chloride of tin will be $Sn\,Cl_2$.

It has been seen that hydrogen unites with oxygen in the proportion of two to one, and that the property which oxygen has of uniting with two atoms of hydrogen, or any other similar monovalent element, is called its "valency;" but sixteen parts by weight of oxygen unite with two parts by weight of hydrogen. Therefore eight parts of oxygen are *equivalent* to one part of hydrogen, and therefore the *equivalent* of oxygen is said to be eight; that is to say, in a re-action eight parts of oxygen can be supposed to replace one of hydrogen. The atomic weight of nitrogen is fourteen, and we have the compound NH_3, ammonia, here; three parts of hydrogen unite with fourteen of nitrogen, and therefore the equivalent of nitrogen is $\frac{14}{3} = 4{\cdot}6$; but nitrogen also combines with five monovalent atoms in $NH_4\,Cl$, chloride of ammonium. It here has another equivalency. In ammonia 4·6 parts of nitrogen are equivalent to one of hydrogen, and in chloride of ammonium it has the equivalent value $\frac{14}{5} = 2{\cdot}8$. This has been regarded as a difficulty, as being at variance with the new theory of atomic weights, and different explanations of it have been proposed. There does not, however, seem any reason why an element should not have two, or even more, combining proportions with the same atomic weight; what is maintained is, not that varying numbers of a monovalent element may combine with one of higher valency, but that no less a weight of that element than its atomic weight can enter into combination with one or more atoms of any other element. Less than sixteen parts of oxygen cannot combine with one or two of hydrogen; less than fourteen of nitrogen cannot combine with three or five of hydrogen, or of any element like hydrogen. If NH_4 be regarded as a metal or basic radical, it must be monovalent, for reasons which will be given hereafter, and it unites with one atom of chlorine in chloride of ammonia; but however the constitution of this salt may be regarded, the fact remains that nitrogen is in it pentavalent. The term combining weight is not, therefore, the same as atomic weight, nor should it be used instead of it. Still less correct is the use of the term equivalent in the sense in which it was formerly used, namely, as synonymous with atomic weight. Dr. Williamson says, in his "Chemistry for Students," "the term 'equivalent' is really synonymous with 'capable of replacing.' It is not intended to

convey the idea of any equality of properties," and this seems to express clearly the meaning and full force of the word. The equivalent of an element can always be ascertained by dividing its atomic weight by the number of atoms of hydrogen, or any other monovalent element with which it can combine.

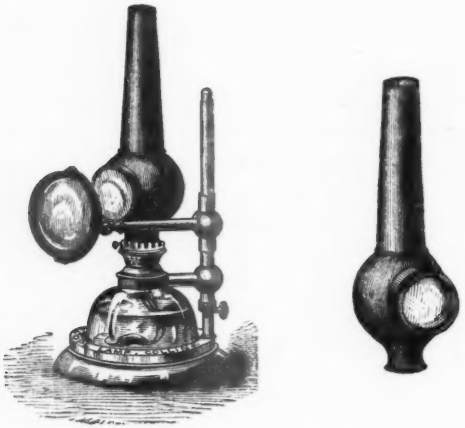
The new atomic weights and the grounds upon which their adoption rests, the constitution of molecules and the laws relating to combination by volume, have been treated somewhat at length, because on the correctness of the principles on which they are based depends the truth of the theories to which they give rise; and without a clear knowledge and thorough appreciation of their merits, it will be impossible to realize the beautiful order and consistency which they have been the means of introducing into the classification of compounds, and into the interpretation of the laws which govern chemical combination and decomposition; not but that there are anomalies which wait for their explanation as research advances, and which, on their being thoroughly understood, may considerably modify theories which at present seem unassailable. But whatever changes may take place, we, at least, know that the endeavours of our most philosophical chemists have been given to render rational what was formerly but empirical; and if the grounds of their reasonings be, in some points, proved defective, still they will have the satisfaction of knowing that they were the originators of that method of thinking and reasoning, which has led to a more rational and correct knowledge of natural phenomena, and has raised their science to a place amongst those which engage the highest powers of the human intellect.

(*To be continued.*)

NEW CHIMNEY FOR MICROSCOPE LAMPS.

Mr. Collins has given us an opportunity of trying a new chimney for microscope lamps, with which we are much pleased, though more prolonged experience is necessary to enable us to speak positively on some points. He calls it "Fiddian's Metallic Shade Chimney," the special method of constructing having been devised by Mr. Fiddian, of Birmingham. It can be fitted to any of the paraffin or photogen lamps ordinarily in use. It consists of a stout tube of copper, formed by the electrotype process in one piece without joints, and has, as the drawing shows, a bulge at the part where

the lamp flame comes. In this bulbous portion a cap fits carrying a flat piece of glass, through which the light passes, no light being



FIDDIAN'S METALLIC LAMP, CHIMNEY, AND SHADE.

emitted in other directions. The inside of the tube is coated with plaster of Paris, which improves the quality of the light, and renders it very intense. It is very pleasant, when using the microscope with this lamp, to have all extraneous light so neatly and completely excluded, without the aid of any cumbersome screen.

This chimney seems to improve the combustion of the paraffin, by burning it at a somewhat higher temperature than when a glass chimney is employed; and hence, as we are informed by Mr. Collins, and as appeared from several hours' trial, there is much less tendency to smoke. Even tilting the chimney considerably on one side did not provoke smoking. As this chimney is quite new, we are not able to say how many months it might be used without requiring a fresh coat of plaster of Paris, but when necessary it is very easy to give it. A little plaster of Paris made into a cream with water is poured in, and allowed to run round by inclining the tube, and the thing is finished.

LITERARY NOTICES.

FARADAY AS A DISCOVERER. By John Tyndall. (Longmans.)—Professor Tyndall's lecture on the life and discoveries of Faraday make an octavo volume of 171 pages, filled with interesting matter, and adorned by two excellent portraits, taken at different periods in the life of the great philosopher. As a brief but excellent summary of the remarkable services which Faraday rendered to science, the present work will be heartily welcomed, and it will be still more esteemed as an eloquent and touching memorial, erected by friendship in honour of one of the most single-hearted and noblest of men. Faraday won for himself the highest rank as an experimental discoverer, and with rare devotion refused opportunities of making a large fortune, and laboured for a mere pittance as an interpreter of nature to his fellow-men. Faraday was a self-made man. At thirteen he was apprenticed to a bookbinder in Blandford Street, Manchester Square, with whom he worked for eight years, and then served as a journeyman. Gaining access to a course of Davy's lectures at the Royal Institution, he took notes of them, and applied to him for employment, and became his assistant at weekly wages, thus humbly entering upon a scientific career. Biographical notices of Faraday have so recently appeared in all the newspapers, that it is not necessary for us to recapitulate the events of his quiet life. In his wonderful course of discovery in chemistry, electricity, magnetism, and many other subjects, and in the warm affections of his domestic hours, he is beautifully sketched by his friend and successor. Such a memoir is worth a host of long-winded biographies, and England, justly proud of the fame of Faraday, may rejoice that she has a Tyndall to render the homage of enlightened admiration, and in some directions at least to continue his profound research.

BRITISH SOCIAL WASPS. An Introduction to their Anatomy and Physiology, Architecture, and General Natural History. With Illustrations of the different species of their Nests. By Edward Latham Ormerod, M.D., Caius College, Cambridge, Fellow of the Royal College of Physicians, Physician to the Sussex County Hospital. (Longmans.)—Dr. Ormerod's book is sure to prove a popular one, as students and observers of matters pertaining to natural history are now scattered all over the country. Much of his work is avowedly compiled from accredited sources, but it contains a considerable body of original observations, and is illustrated by a beautiful series of drawings of wasps' nests made by Mrs. Ormerod, and fully justifying her husband's statement that there can be but one opinion about them in accordance with his own. There are also coloured figures of English wasps. Dr. Ormerod's affection for wasps leads him to declare that wasp-keeping is as profitable as bee-keeping, to which we apprehend bee-keepers will demur; but his book will induce many to forego their dislike to an insect not

overburdened with public favour, and to watch its highly curious habits and proceedings. It will appear that, during the busy and most interesting portion of a wasp's life, the creature is inoffensive unless assailed. It is when the work is done and the society broken up, that wasps become a nuisance, like other idle folks. We could have wished Dr. Ormerod had drawn more largely upon notes of his own observations, as he must have met with many important illustrations of what it is the fashion to call the instinct of these creatures, though much of it is indistinguishable from the reason of higher animals, except in degree. He tells us that if a wasp's nest is destroyed early in the season, the insects make a new one, and will do so several times in succession. "Each of these successive nests bears more than a mere generic resemblance to the original structure, the peculiarities of the preceding nest being in some sort reproduced. They do not, however, pass through all the same stages as the original fabric in their development, for they are built up at once, on the scale and outside plan of that which has been removed. And this fact necessarily involves some important differences in the details of their construction; for instance, the upper part or crown of the nest is not made of the remains of older structures worked into each other, but of distinct sheets of paper closely applied one over the other. . . . Again, the new camp differs from the original structure, the formation of the cells is less regular, and the stages are arranged differently. . . . Each time that the nest is replaced it differs more and more from the original type," and after it has been destroyed three or four times, the survivors make no attempt to replace it. Dr. Ormerod should publish further matter of this sort, with some more of his wife's excellent drawings to illustrate the successive changes the wasps make.

JERROLD, TENNYSON, AND MACAULAY, with other Critical Essays. By James Hutcheson Stirling, LL.D., author of the "Secret of Hegel," etc. (Edmonstone and Douglas.)—Essays upon well-known living characters and their writings, or upon authors recently departed and whose works are in frequent circulation, are very ticklish things. It is supposed by the credulous that ponderous magazine essays of this kind actually find readers. Dr. Stirling's essays have much more than average merit, and though we differ from him on some points, we find much to agree with. The most interesting of his papers refers to Ebenezer Elliott, and for this we heartily recommend his volume to our readers. Elliott was a noble spirit, and though thoroughly appreciated in some circles, was not known too widely to take the edge off the interest of such a notice as Dr. Stirling has given him.

GROOMBRIDGE'S ANNUAL READER, and Repertory of the Principal Events of the year, from October, 1866, to October, 1867, for the use of Schools. By Mark Antony Lower, M.A., F.S.A., Member of the Academy of Sciences of Caen, etc. (Groombridge and Sons.)—The idea of this book is exceedingly good, and the execution such as to give it a firm hold on

the class for whom it is intended. It is, however, not exactly "a repertory of the principal events of the year," nor do we think such an encyclopedic character would be advisable for the purpose in view. It is a well-made selection from the events of the year, recorded and commented upon in a style that will win the attention of pupils in the better sort of schools, and supply them with a large amount of useful information. There has been a great want of books adapted to reading aloud, and possessing the sort of qualities which we are glad to recognize and welcome in "Groombridge's Annual Reader." It is frequently not advisable to select for class reading portions of large works. If the work is a good one, taking it piecemeal may spoil a boy's interest in it for life. Judicious selections, fitting particular times and circumstances, a teacher fit for his vocation, and in possession of a good library, can easily make; but things actually going on, history just fresh from making, has a great and invaluable charm. The first volume of "Groombridge's Annual Reader" contains more than seventy articles on a great variety of topics belonging to the year. Some notice of the Atlantic Telegraph, under the title "Those whom the Queen Delighteth to Honour," is followed by the "Meteoric Shower," "Attempt to Assassinate the Emperor of Austria," "Dreadful Fire at Quebec," "Visit of the Prince of Wales to Russia," "Great Frauds in the North of England," etc., etc. Science, politics, wonderful incidents, social events, and archæological discovery, all make their appearance in Mr. Lower's pages, and the volume, handsomely printed, has been judiciously limited to about 400 pages, so that it can be sold at a very moderate price. Though avowedly intended for schools, its circulation ought not to be limited to such establishments. It is a good popular work, and might be widely circulated with advantage.

A SHORTHAND DICTIONARY; comprising a complete alphabetical arrangement of all English Words, written without Vowels, adapted to all systems of Shorthand Writing, and designed for the use of gentlemen connected with the Press, the Bar, the Pulpit, and other professions. By J. B. Dimbleby. (Groombridge and Sons.)—Those who wish to learn shorthand, and those who have learnt a little of its use, should have this book, as it will save them a world of trouble and vexation. The practice of writing shorthand would increase much quicker if the task of reading it when written presented fewer difficulties, and Mr. Dimbleby has produced exactly the right sort of work for this purpose. Many words reduced to the shorthand standard by the omission of vowels are easy enough to understand, but dreadful puzzles continually arise in the way of all but well-practised stenographers. This compact, portable dictionary will afford welcome and inestimable aid. Suppose, for example, the letters bnls are encountered, and that memory has lost the clue to their interpretation, and that the context does not force it into notice, what a comfort to have a book to refer to which at once gives a

choice between biennials, boneless, baneless, and boonless; or take gs, which may stenographically indicate gas, gauze, gaze, geese, goose, guess, guise, Jesus, joyous, juice, ages, eggs, goes, gags, gaseous, joys, and gigs, and it will be at once seen how much such help is needed as Mr. Dimbleby affords. Shorthand students can appreciate the difficulties of translators of Hebrew written without points, and thus to some extent resembling their own mode of writing, and supplying analogous puzzles to commentators.

An Elementary Treatise on Conic Sections and Algebraical Geometry, with numerous Examples and Hints for their Solution, especially designed for the use of Beginners. By G. Hale Puckle, M.A., St. John's College, Cambridge, Head Master of Windermere College. Third edition, revised and enlarged. (Macmillan and Co.)—It is only necessary, on the appearance of a new edition of an established work, to notify the fact of its issue, and to mention any important changes. Mr. Puckle says, in reference to this third edition of his book, that he has re-written and re-arranged a large portion of it, and thoroughly revised the examples. A mathematical work never comes to a third edition without possessing considerable merit, and that of Mr. Puckle is well known.

The Life of Sir John Richardson. By the Rev. John McIlraith, Minister of the English Reformed Church, Amsterdam. (Longmans.)—The famous Arctic explorer whose biography is now presented to the public well deserved a popular record of his services, and of his fine-hearted character. His career was a very honourable one, and he won his way upwards by qualities eminently deserving of respect. This life of him, without reaching any high degree of merit, is fairly and interestingly done.

The Mineralogist's Directory; or, A Guide to the Principal Mineral Localities in the United Kingdom of Great Britain and Ireland. By Townshend M. Hall, F.G.S. (Stanford.)—This is a very handy book for mineralogists and geologists, with which Mr. Hall has evidently taken great pains. The various counties in Great Britain and Ireland are arranged alphabetically as chapter-headings; under each an alphabetical list is given of the places at or near which characteristic minerals are to be found. Preceding this main portion of the work is a list of 246 British minerals, with their chemical composition. At the end of the volume the localities of pseudomorphic minerals are separately given, followed by an appendix, containing useful chemical and geological notes.

Mr. Hall puts forth this convenient little volume in a very unpretending spirit. It represents a large amount of labour, and cannot fail to be valued by tourists interested in the objects to which it refers. We hope he will receive sufficient encouragement to bring out a second edition, with such additional information as may be communicated to him, and in that case we would suggest a few more hints as to the precise locality of some of the rarer minerals.

ARCHÆOLOGIA.

At a recent meeting of the British Archæological Association, Mr. Syer Cuming, one of its vice-presidents, made an interesting communication on the remains of large Roman bronze statues which have been at different times found in London. The Roman bronzes found in Britain, though often of very good workmanship, are generally of small dimensions, and fragments of statues of bronze of any magnitude, for it is only fragments we find, are extremely rare. In fact, only four such fragments are at present known to have been found in London. The most remarkable of these is a fine colossal head of the Emperor Hadrian, dredged up from the bed of the river Thames a little below old London bridge in 1832, and now deposited among the treasures of the British Museum. A good engraving of it was given with the first volume of the Transactions of the British Archæological Association. Mr. Cuming pointed out, as a singular circumstance, the fact that all the other evidence we possess of the existence in Roman London of large bronze statues has come to us in the remains of hands, and that they have all been found within a very limited space, and on the eastern side of Roman London. In 1855 was found, towards the Tower Hill end of Lower Thames Street, a right hand of bronze, with the first joint of the thumb broken off, the index extended, and the three other fingers folded on the palm. The wrist was eleven inches in circumference, and the whole length thirteen inches. It was formerly in the collection of Mr. Roach Smith, but is now in the British Museum. In 1833, in the course of excavations in Fenchurch Street, among a considerable number of relics of the Roman period, there were found two bronze fingers, which Mr. Cuming exhibited in illustration of his paper. They had evidently been broken from a very large muscular hand. They were severally five and four-and-a-quarter inches long. As, close to these antiquities, were found very handsome tessellated pavements and the bases of walls, Mr. Cuming thinks that the statue to which these digits belonged may have stood in the *atrium* of some mansion of importance. The last discovery of this kind occurred in the middle of the month of October, 1867; it consisted of a well-proportioned left hand, which was found on the site of the old inn, the *Spread Eagle*, in Gracechurch Street. It also was exhibited at the meeting to illustrate Mr. Cuming's paper. Its dimensions are: Length from the tip of the finger to the fractured edge of the wrist,

nine inches and three-quarters; breadth across the knuckles, four inches and a-half; circumference of the wrist next the hand, seven inches and five-eighths; circumference at the fractured end, eight inches and a little more than five-eighths. The thumb and the first and second fingers are nearly extended, but the two other fingers are folded towards the palm, the little finger having sustained a blow, which gives it rather a hooked form, and has produced rather a slight fissure on the back of the hand. Traces of gilding were perceptible on some parts of the surface. This hand also was found near a handsome tessellated pavement.

These are all the traces of bronze statues hitherto known to have been found in London. Mr. Cuming enumerated as the sum total all the remains of objects in this metal of any considerable size found in the whole of Britain, out of London, the superb helmet, with its persona, found at Ribchester, in Lancashire; and the statuette of the loricated soldier found near Barking Hall, in Suffolk, in 1799 (both now in the British Museum); the leg and hoof of a horse, found at Lincoln (now in the Museum of the Society of Antiquaries of London), and the head of Apollo, exhumed at Bath.

Perhaps we may be able to throw some light on the cause of the hands or fingers only of so many of these statues being preserved. The people of the middle ages, those who came here after the Romans, were ignorant and superstitious, and they believed that the works of Roman art which remained were filled with enchantment and magic. A Roman inscription was, to them, a dangerous charm, the more so as they could not read the letters, and they believed that the force of the charm could only be destroyed by mutilation. In very recent times, the peasantry of Northumberland along the line of the wall of Hadrian were accustomed, when they turned up an inscribed Roman stone, to erase some of the letters with a pick or axe, before they would venture to use it for building purposes. All bronze figures of human beings were supposed similarly to contain a dangerous spell, which could only be broken by mutilation of the figure; and this is the cause of our finding so many mutilated small bronzes. When people found a bronze statuette, their first impulse was to destroy the spell it might contain by mutilating it with an axe, or any other implement at hand, and they then threw it away—the Londoners often into the Thames, and hence so many mutilated bronzes have from time to time been dragged from the mud of the river. But these same people were quite alive to the value of bronze as a metal, and they

were not inclined to lose so much of it as was contained in a colossal statue, though they still had the same fear of the charm, and sought to get rid of it by the same process of mutilation the moment they found it. It is evident that the part of a large statue easiest to hew or cut off was the hand, and there can be little doubt that for this reason they struck off the hand of the statue and threw it away, and then proceeded to appropriate the metal of the body for other purposes.

We are able to add some particulars to the account of the Excavations in Bath, described in our last. The ancient remains brought to light belong to two periods, Roman and mediæval, the latter chiefly ecclesiastical, for the site of the ancient temple had, as was not unfrequently the case, been seized upon partly for the foundation of an abbey, and here stood the church of St. Mary le Stall, built in early Norman times, which gave to the present thoroughfare the name of Stall Street. The excavations were commenced in September of last year, for laying the foundations of the front wall of the wing of the hotel adjoining Westgate Street, and among the first discoveries was that of a quantity of mediæval pottery, among which were some fragments of a very fine example of the curious glazed earthenware figures, generally of a knight on horseback, of which several examples are now known, and they are mostly of a rather early date. This example appeared to be not later at least than the time of Edward I. Remains of the old ecclesiastical buildings, etc., were found, with some early sepulchral monuments. A strong wall of the Roman period was also met with; it was two feet three inches thick, and its lower part was built with herring-bone work, and went down into the unmoved blue clay. During the following month, many remains of the old ecclesiastical buildings were brought to light, and towards the end of the month the workmen came upon a rough Roman pavement, formed of concrete, covered with thin slabs of pennant stone, which was found to be close to the Roman temple. The month of November was rich in discoveries, chiefly of remains of the Roman period. These consisted for the most part of walls running in different directions, and it was eventually found that the excavators had got into the open court of a Roman building, with low lean-to buildings round the exterior walls, and that the buildings of the new hotel covered the greater part of this open court. On the 20th of November, under the foundation of the north-west partition of the central portion of the hotel, a fragment of a fine churchyard cross of rich Norman work was found. It was the lower arm, and bore

part of the eagle, the emblem of St. John, and the circle which had united the arms. Other remains of mediæval sculpture and architecture were found, which Mr. J. T. Irvine, well known as a careful investigator and observer, thinks may be Anglo-Saxon. Towards the end of November, the excavators came upon the raised platform of the Roman temple, which was formed of solid masonry, and several portions of it appear to have had forced holes sunk in them, to form cess-pools. Early in December, a circular well was discovered, close to the exterior of the south wall of the stairs to the new hotel. It was about fifteen feet deep, and was roughly paved at the bottom, the walling being entirely composed of fragments from the abbey buildings, mostly of Norman and early English date. In clearing it out, were found the lower portion of a fine column of the perpendicular style, supposed by Mr. Irvine to have formed part of the rood-screen of the abbey church, an old bucket, and many fragments of pottery, all of a date subsequent to the year 1500. On the 6th of January, the foundation of the south wall of the temple was discovered, but one course only of the immense stones which formed it remained. One stone was more than five feet long, and had a sawn face, proving that the stone saws used by the Roman masons could not have been less in length than those used at the present day. Close to the wall, a beautiful glass mask was found, which had been originally attached to a vessel of thin glass. A Roman wall has been since found, parallel to the south wall of the temple. The excavations are discontinued for the present, but it is intended to resume them on a future occasion, and then we understand they are to be carried on not far from the Cross Bath, and we may hope for antiquarian discoveries of very considerable importance.

At a recent meeting of the Archæological Institute (Feb. 7), Mr. Edward Tindall of Bridlington, in Yorkshire, exhibited a very large collection of FLINT IMPLEMENTS, gathered by himself on the wolds and plains of that part of the EAST RIDING in which Bridlington is situated. Mr. Tindall has been known for many years as an active and zealous collector of these objects, and these are especially important—from the circumstance that we know them to have been found by himself personally, on the surface, or not very far below the surface of the ground, and in some cases on the sea-shore. This district was during the Roman period, and long after the Roman period, an extremely retired and wild part of the country, and had no doubt little communication with the more cultivated parts of Britain. We need no stronger proof of this than the fact

that, even in Anglo-Saxon times, its streams were frequented by beavers, from which circumstance one of its earliest religious foundations took the name of Beverley, the field of beavers. The inhabitants of this district seem to have lived chiefly by the chase, and a large majority of these flint implements were weapons which were used for killing quadrupeds, birds, or fishes, consisting of such articles as sling-stones, arrow-heads, and fish-hooks. The barbed arrow-heads and barbed fish-hooks were evidently made by men who were well acquainted with similar objects made of metal, of which they are imitations, and there is no reason whatever to suppose that these flint implements generally belong to an older period than that of the Romans. In a retired district like this, when intercommunication with the rest of the world was slow and uncertain, metal would not be always available, and would no doubt be dear. Mr. Tindall's collection is of so much interest in connection with Yorkshire, that we cannot but hope that it will eventually be secured for one of the great local museums, at York or Leeds.

A few weeks ago, at a former meeting of the Archæological Association, Mr. George R. Wright, the Secretary of the Junior Athenæum Club, and one of the officers of the Association, exhibited a finely-sculptured head, in marble, which he had received from Alexandria, where it was dug up in a garden. It was ascertained that the body of the statue also lay buried in the same spot, but it had been left undisturbed. It was the general opinion that the head belonged to a statue of the Roman emperor Marcus Aurelius Antoninus, who reigned from A.D. 161 to 180.

T. W.

PROGRESS OF INVENTION.

MANUFACTURE OF CHARCOAL, BY C. DROMART.—On account of the value of wood, an economical method of converting it into charcoal is very desirable. The advantage of M. Dromart's method over the old system of burning in heaps is very great, he effects a saving of at least 30 per cent. of wood at a comparatively less cost. The apparatus he employs is of a dome-shape, the diameter of its base being 5·25 metres, and its height 4·50 metres. At the top it has a chimney a metre high, and 0·7 metre diameter; this chimney is tubulated, so that a fire can be lighted in it to cause a draught. The framework of the dome is formed of an iron ring, with curved ribs of iron attached to it, and which give the top its dome-like shape; they are connected above by an iron ring,

to which the chimney is fixed; the intervals between the ribs are closed hermetically by thin iron plates. The whole iron should not weigh more than two hundred kilogrammes, so that it can be moved about easily. A second iron covering serves as a protection against rain; and to prevent the escape of heat, the apparatus is covered with earth to the thickness of two metres. The holes for the draught and two doors are made of wood curved to the form of the iron-work. For heating the chamber, an apparatus is made of cast-iron and Stourbridge clay, and is placed beneath it; to this are connected ten tubes, arranged in the form of a fan, so that the heat may be equally distributed to the whole; by opening and closing these tubes the heat is regulated. The wood is then carefully packed within the chamber in the usual manner, a strong fire is made on the hearth, which is kept burning during the operation, that in the chimney being only used for a short time to create a draught. In ten hours the temperature of the stove is 100° C.; the water then goes off; at 150° C., dark fumes pass out; these are caused by volatilization of the tar; at 330° C., no smoke is seen, and then the process is completed. To obtain a stronger charcoal from denser wood, the temperature should reach 420° C., and should be continued for an hour and a half. The temperature is determined by melting metals. The advantages of this method, beyond the greater yield obtained by it, are, that there is no fear of loss from explosions, men easily learn to work it, and the time occupied in making the charcoal is much less than that required by the common process.

An improved Sink Trap.—As it is very desirable to prevent the rising of impure and deleterious gases from sinks, etc., any simple and effective method of doing so will be very acceptable. The present invention is one which requires no springs, or complicated apparatus liable to get out of order; it consists of a ring with a broad projecting flange, which rests on the bottom of the sink immediately over the pipe, and can be secured in the usual manner; to the barrel of this ferrule are pivoted two half funnels, which together form a hollow cone. These project downwards into the pipe, and when empty, that is, when nothing is passing through them, close by their own weight, but when liquids are passing through from above they are forced open. When closed, the longitudinal joint between the two halves of the cones, is air and water-tight, and wholly prevents the escape of unpleasant and noxious effluvia. The flange may be constructed to stand at an angle with its barrel without destroying the action of the two half funnels. These may be made in three parts, if desired; the only objection being the formation of another air-tight joint. It may also be used to admit volatile liquids to a vessel, but prevent their escape by evaporation.

Aluminium Glass has been made by melting respectively 40, 50, 60, and 80 parts of alumina with a mixture of 250 parts of pure sand, 100 parts of carbonate of soda, and 50 parts of carbonate of lime. These

glasses, produced by M. C. Pelouze, have been specially examined by M. Baille; he found their indices of refraction to be as follows:—

	40	50	60	80
For line C ...	1·5115	1·5120	1·5143	1·5153
„ D ...	1·5133	1·5137	1·5159	1·5167
„ F ...	1·5210	1·5211	1·5224	1·5232
Middle index...	1·5172	1·5174	1·5192	1·5200

Therefore the index of refraction increases with the alumina, but dispersion decreases; its co-efficient being in the several cases—

0·00185, 0·00177, 0·00154, 0·00153.

Whereas, in crystal glass the power of refraction and dispersion increase with the per centage of lead employed.

Results of Experiments on Air in Rooms lighted by Artifical Light, by Dr. Branislaw Zoch.—These experiments were made with gas, petroleum, and oil, and the quantity of carbonic acid formed in a given time was measured. They were made in a space of 100 cc., lighted by a light equal to ten normal flames, and the following results were obtained:—

Time.	Petroleum.	Gas.	Oil.
1 hour	0·0929	0·0708	0·0537
2 hours	0·1456	0·1342	0·1038
3 hours	0·1779	0·1513	0·1190
4 hours	0·1811	0·1562	0·1229

Hence petroleum for equal light gives more carbonic acid than gas, and gas more than oil. With petroleum the air became lighter and very disagreeable, not only on account of the carbonic acid formed, but from the volatile products of distillation. These researches show also that in three hours we obtain the maximum of carbonic acid.

A New Method of applying Cold in Diseases of the Human Body.—Rags dipped in water—in fact, every method of applying water-dressings—is open to the objection that, from the instant of application the temperature of the dressing begins to rise; where *steady* cold is required at a temperature above melting ice, the invention of Dr. Prentiss, of Kansas, U.S., will be found thoroughly efficient. A thin India-rubber tube, seven or eight feet long (longer, if required), is coiled in the form of a lamp-mat, to the desired dimensions, and kept in form by means of bands extending from the centre to the circumference; one end of the tube being left sufficiently long to dip into a pail of water of the required temperature, the other end leading into another pail, placed to receive the water after its passage through the coil. This end should be provided with a stop-cock, or be compressed by a clip, so as to regulate the rate of the current. In this manner a constant flow of water, at any temperature, may be maintained. The smaller-sized tubing answers best.

NOTES AND MEMORANDA.

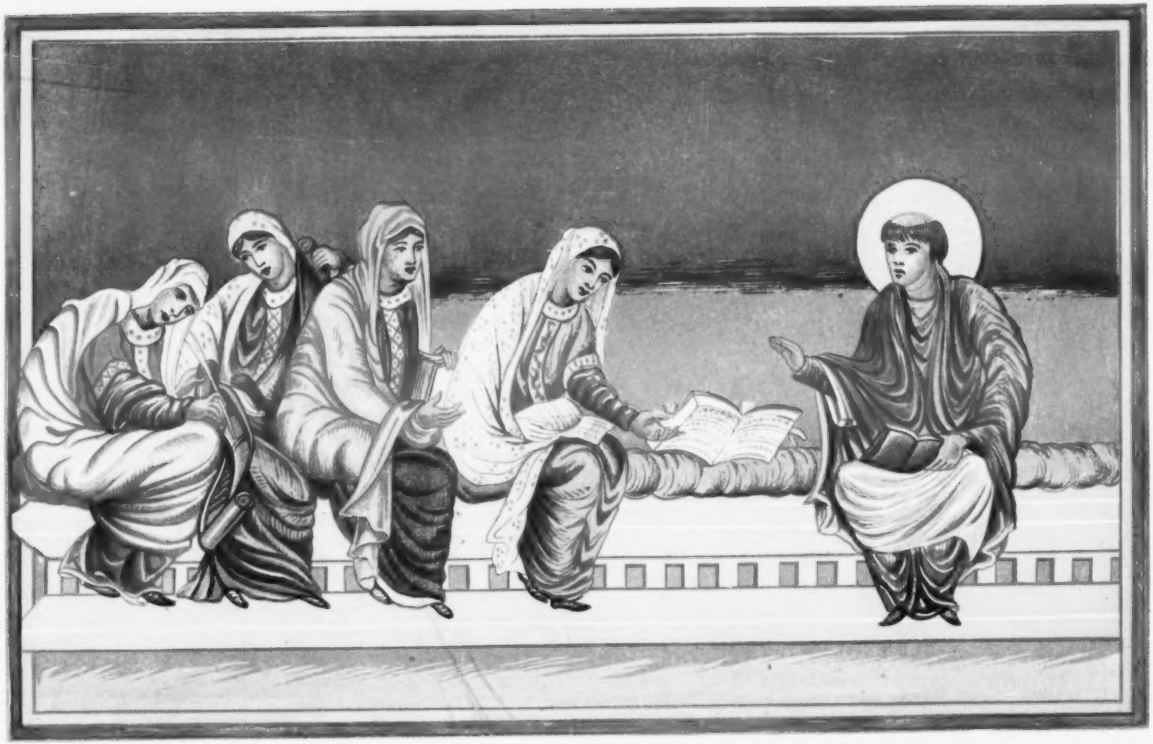
ASTRONOMICAL ITEMS. — At the Astronomical Society, March 13, Mr. Simms exhibited and described a new instrument for determining latitudes by a method called "American." It consisted in observing the zenith distance of two stars, differing nearly 12 hours in R.A., on each side of the zenith, at no great distance from it, turning the instrument through 180° of azimuth between the two observations. Some observations of small planets (including the last-discovered No. 97), by Dr. Luther, were communicated. The Rev. H. Cooper Key sent some very interesting observations of the planetary nebula 45 H IV. Geminorum, by which it would appear that it has undergone some remarkable changes since it was observed by the Herschels. Mr. Marth communicated (through Mr. Lassell) a note on the occultation of Aldebaran, which will occur on the 22nd of May next, which will be interesting from occurring within twelve hours of the Moon's conjunction. The disappearance and reappearance will take place respectively at 6h. 26m. and 7h. 12m. in the evening. Professor Hoek, of Utrecht, sent two papers, one on the appearance which would be presented by a swarm of meteors approaching the earth; the other on cometary systems. The Rev. T. W. Webb sent some further observations of the crater Linné. In the "Astron. Nachrn." (1683) is an elaborate paper on the proper motion of 70 p Ophiuchi, by Mr. W. Schur. He makes its distance from the solar system 1,273,000 times the earth's diameter from the sun, and its distance measured in "light years" (as the Germans call the space traversed by light in a year) as 20·1.

THE ACTIVE PORTION OF VACCINE MATTER.—M. Chauveau details to the French Academy the results of experiments, which seem to show that the serum of vaccine matter or of glanders does not communicate the disease by inoculation, but that the virus is contained in the corpuscles or cells.

MICRO-FERMENTS IN CARBONATE OF SODA. — M. Le Rique de Mouchy states ("Comptes Rendus"), that if commercial bicarbonate of soda is dissolved in distilled water and filtered, numerous minute moving bodies may be found amongst the residue left in the filter, and that they are able to induce the fermentation of a saccharine solution.

ANTISEPTIC PROPERTIES OF ETHER.—M. Martin states ("Comptes Rendus") that ergot of rye, cantharides, portions of meat, and various other substances liable to attack from worms, insects, or putrefaction, may be preserved by being moistened with sulphuric ether, and kept in hermetically-stopped bottles.

HUXLEY ON THE ARCHÆOPTERYX.—On Jan. 7, Prof. Huxley read a paper before the Royal Society on the Archæopteryx. He considers that Prof. Owen took the right leg for the left, and made similar mistakes with other bones. He considers the bone supposed to be the "furculum" to present the greatest osteological difficulties, and waits for further specimens to elucidate them. He says that he is not aware of any law of correlation which would enable us to infer that the mouth of this animal was a toothless beak. "If," he says, "when the head of Archæopteryx is discovered, its jaws contain teeth, it will not the more, to my mind, cease to be a bird, than turtles cease to be reptiles because they have beaks. All birds have a tarso-metatarsus, a pelvis, and feathers, such in principle as those possessed by Archæopteryx. No known reptile combines these three characters, or presents feathers, or possesses a completely ornithic tarso-metatarsus or pelvis." In many respects he thinks Archæopteryx more remote from the boundary line between birds and reptiles than some living *Ratitæ*.



FRANKISH LADIES OF THE NINTH CENTURY.
(St. Jerome reading to Eustachia and Paula.)

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